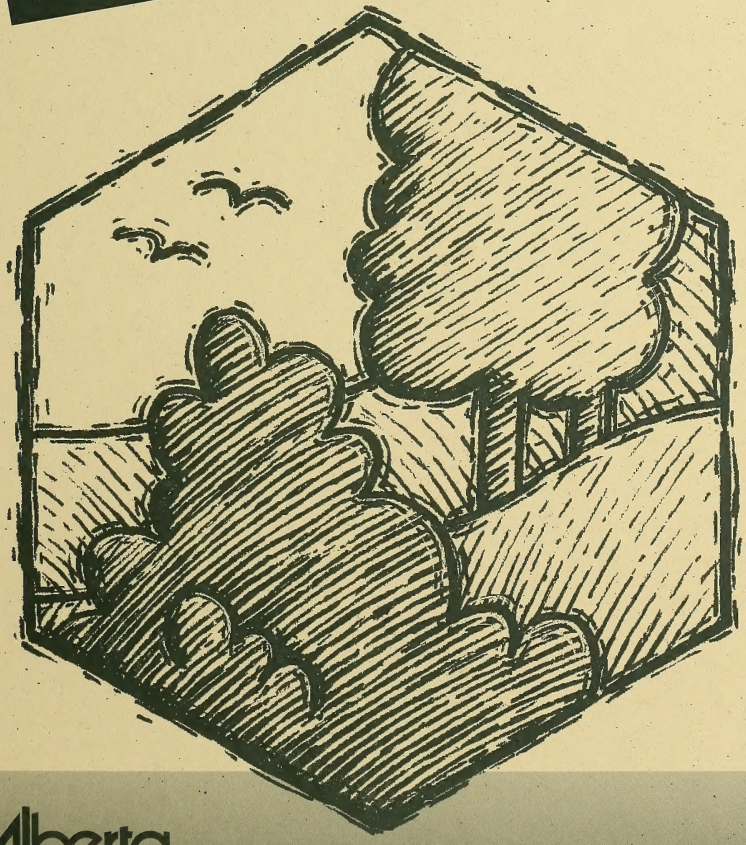
WAINWRIGHT DUNES

ECOLOGICAL RESERVE

Management Plan



Alberta
AGRICULTURE, FOOD and RURAL DEVELOPMENT

Alberta
ENVIRONMENTAL PROTECTION

WAINWRIGHT DUNES ECOLOGICAL RESERVE

MANAGEMENT PLAN

FEBRUARY 1998

SUMMARY OF THE WAINWRIGHT DUNES ECOLOGICAL RESERVE MANAGEMENT PLAN

The Wainwright Dunes Ecological Reserve, an area of approximately 2800 ha, was established by Order In Council, January 14, 1988. This reserve is representative of the Aspen Parkland on sand dune and sand plain landforms and contains unique features, including the most southerly representation of boreal fen ecosystems. Accompanying the parkland and fen ecosystems is a rich diversity of plants and animals including rare species.

The primary goal of the plan is to protect the representative and special features of the reserve. The plan accomplishes this goal through a number of hands-off, low impact management strategies. However, this plan also recognizes the need to produce and maintain artificial impacts when natural sources are no longer available or practical, i.e. fire, grazing herbivores and predators. A key strategy to accomplishing goals is the establishment of a Wainwright Dunes Ecological Reserve Management Committee.

This management plan provides the overall direction for the protection, management, and operation of the reserve.

In 1991 the following planning team of members was struck to prepare a draft management plan for the Wainwright Dunes Ecological Reserve. The plan was developed following the 1988 Terms of Reference.

PLANNING TEAM MEMBERS

Core Members: Public Lands, Federation of Alberta Naturalists, Alberta Fish and Game Association, Alberta Fish and Wildlife, Alberta Parks and Recreation, Alberta Wilderness Association, Buffalo Park Grazing Association, Canadian Parks and Wilderness Society, and Wainwright Wildlife Conservation Society.

Consultative Members: Alberta Culture, Alberta Energy, Alberta Environment, Camp Wainwright, Canadian Jorex Ltd., Ducks Unlimited Canada, M.D. of Provost, and David Blue.

Using the 1988 Terms of Reference for this reserve and planning team discussion, a number of issues were identified:

- Role of shrub and aspen encroachment onto grassland ecosystems;
- Degree to which neighbouring land uses impact the Reserve's landscapes and ecosystems;
- Role of livestock grazing;
- Role of hunting;

- Protection of significant features, i.e., slope fen;
- Petroleum and natural gas extraction;
- Role of horse use;
- Protection of rare plant species;
- Protection of rare animal species;
- Reclamation of disturbances;
- Recreation use;
- Trapping;
- Motorized vehicle access;
- Weed control;
- Fire and other disturbances resulting from Camp Wainwright exercises;
- Role of fire as a management tool; and a
- Management committee to implement, monitor and revise the management plan.

Using the "round table", consultation, referral and concencus building methods, the planning team addressed these issues and recommends the following objectives and actions to be taken:

RECOMMENDED MANAGEMENT GUIDELINES WAINWRIGHT DUNES ECOLOGICAL RESERVE	
FEATURE/ACTIVITY	OBJECTIVES/ACTIONS TO BE TAKEN
6.0 PROTECTION (RESOURCE MANAGEMENT) 6.1.1 Geologic and Geomorphic Resource Management	• To maintain processes that promote areas of active dune instability. Research is required to determine the role of fire, grazing and climate in maintaining areas of active dune instability.
6.1.2 Atmospheric Resource Management	• To manage the effects of airborne pollutants on ecological reserve resources. • To monitor ambient air quality to determine baseline data. • To comply with air quality standards that suit the environmental and aesthetic values. • To monitor for hazardous levels of industrial pollutants.
6.1.3 Aquatic Resource Management	**Surface Water Objectives** i) To provide a better

	understanding of water supply conditions in the Reserve, David Lake water levels should be monitored regularly at least twice a year, after spring runoff and in fall. A benchmark should be established for this purpose. ii) Baseline water quality monitoring should be done for David Lake, the ponds, creeks, and fens to provide information useful to understanding the survival needs of some of the rare fen and wetland species and to help track enrichment due to livestock grazing. Once baseline quality is determined, monitoring to track change should be done only at 5 year intervals but more frequently if contamination or other problems are suspected. iii) The ponds, streams, wetlands, and springs should be monitored twice a year, spring and fall, by visual inspections. These should check for the amount of flow and clarity of the water, and for any disturbances. Observed conditions should be recorded in a log.
	iv) No diversion of surface water flow within the Ecological Reserve or the contributing watersheds should be permitted.

	v) The spoil piles beside the David Lake DU level ditches and the new livestock dugout should be spread and sown with natural grasses as required by permit conditions. **Groundwater Objectives** Baseline data on groundwater conditions in the Reserve and surrounding area should be obtained. Management should include the following measures: i) A survey to identify wells and their uses and to confirm that there are no significant groundwater users. ii) A survey of springs to identify locations, estimate flows, and determine water quality. iii) After baseline data is determined and as long as major industrial or agricultural development within the contributing watersheds is restricted, ongoing groundwater quantity and quality monitoring is not considered necessary.
	iv) The use of shallow groundwater or springs within the Ecological Reserve or the David Lake watershed should be limited to non-motorized recreational use or domestic needs.

	If recreation becomes an approved use on the Reserve, physical protection of the source of the springs should be considered, as well as measures to prevent groundwater contamination. **Referral Objectives** • All applications for surface or groundwater permits and licences within the watersheds contributing to the Reserve and David Lake should be referred to the Manager of the Ecological Reserve for input.
6.1.4 VEGETATION RESOURCE MANAGEMENT 6.1.4.1 Plant Species Management	• To carry out a complete survey of non-vascular and vascular plants and their habitats in the Wainwright Dunes Ecological Reserve. To maintain an updated list of these species. • To monitor the presence and abundance of rare species to evaluate ecosystem function and health. • To monitor representative species, ie. rough fescue, as a measure of ecosystem function and health.
6.1.4.2 Fire Management (Shrub and Aspen Encroachment)	• Preparation of a plan that includes the following objectives: to define the range of the desired amount of aspen encroachment onto grassland plant communities; to determine the present ratio of aspen to grassland plant communities; and to monitor changes in this ratio over time. • Preparation of a prescribed burning plan that includes

	goals and objectives according to the protection needs of species, habitats and special features. • Preparation of a fire suppression plan to address the need to extinguish wildfires. This plan would include a discussion of prevention, detection, suppression and postfire rehabilitation. • Ensure that visitors are aware that campfires are prohibited. The use of portable camp stoves for cooking is permitted. • Ensure that the burning plan includes the involvement and agreement of the DND, adjacent local residents, MD of Provost and MD of Wainwright.
6.1.4.3 Grazing Management	• The number of grazing cattle must be in balance with the available forage supply. This number may be adjusted yearly based on range condition, moisture and other management factors. The Animal Unit Month concept will be used to calculate the grazing capacity each year. • Cattle will be allowed to graze in late summer and during the dormant part of the growing season (July to September). This restricted grazing period will minimize injury to plants during their active growth period (May to July). • Range management techniques shall include minimal fencing and the use of ecological principles and practices for range management. Intensive fencing and the use of agronomic principles and

	practices of tame pasture management will not be used. For example, stocking rates will be based on sites and ecological condition classes instead of basing them on the results of using artificial elements, i.e. chemical fertilizer. This type of management will help to enhance the diversity of habitats, species and niches. • Range management shall minimize grazing in the fen systems. Salt blocks will be placed a minimum of one quarter mile from all watering points (natural and man-made). • The grazing contractor (presently Buffalo Park Grazing Association) is responsible for maintaining of all cattle fences including the perimeter, drift and crossfences, and removing of all associated litter such as barbed wire and twine. Temporary portable corrals can be erected for putting cattle onto the range and removing them in the fall. • The grazing leaseholder cannot use a motor vehicle except when putting out salt blocks, repairing fences, tending sick animals, or in other special circumstances relating to grazing management. Motor vehicles can be used only on existing access routes, and horse use is encouraged where practical. • A plan shall be developed to monitor cattle grazing and evaluate the impact. Grazing may then be adjusted to enhance the

	positive impacts while minimizing the negative effects. The plan shall include the monitoring of plant species, habitats and several range reference areas to compare plant community composition and productivity in grazed versus non-grazed conditions. One goal of the grazing management strategy is to maintain all plant communities in excellent ecological condition. • The ecological condition of David Lake shall be improved from fair to good. Presently the Dunes area is rated in excellent ecological condition. • Existing range improvements (dugouts, fences, fence lines and trails) are to be maintained in good condition. No additional range improvements are permitted in the ecological reserve unless they are required for ecological management purposes.
6.1.4.4 Weed Management	• Management of weed will be consistent with the direction of the Weed Control Act. • A common sense approach should be taken to controlling weeds, selecting the method that has the least negative impact on the purpose of the ecological reserve. Methods for controlling weeds include hand picking, mechanical, biological, and chemical. • No native or tame hay is permitted to be brought into the ecological reserve. • No use of introduced

	species are permitted in the ecological reserve. • Any use of herbicides must be target specific (selective) and applied in accordance with the regulations, acts and regulatory authorities. • The management committee shall prepare a list of potential weed species for the Wainwright Dunes Ecological Reserve.
6.1.4.5 Introduction of Exotic and Non-ecotypic Species Management	• The use of introduced, exotic (ie. crested wheatgrass) or non-ecotypic native species (ie. rough fescue seed from outside the area) is not allowed in the Wainwright Dunes Ecological Reserve.
6.1.4.6 Significant Features Management	• A low level of use by livestock in the active blowouts in the southwest corner will continue. These blowout areas contain one of only two populations of sand nut-grass found in Alberta. The other population is found at Pakowki Lake in southeastern Alberta. In this ecological reserve, this species is not in an area that is being grazed heavily. • To protect the moist meadow west of David Lake where moss gentian grows. • To protect the central part of the large fen which supports a population of slender-leaved sundews. • To protect the slope fen north of David Lake that supports a number of uncommon and disjunct species. • To develop a plan that priorizes which uncommon and disjunct species will

	be monitored.
6.1.5 ANIMAL RESOURCE MANAGEMENT 6.1.5.1 Habitat and Species Management	• Access for hunting is by foot only. • Management and harvesting ungulates will be based on the best possible animal census data from the ecological reserve and neighbouring lands. It is recommended that any plan for hunting in the ecological reserve be coordinated with the Camp Wainwright Military Reserve census, harvesting and monitoring plan. • It is recommended that a self-registered harvest is used to calculate the actual number of animals harvested. • Commercial and recreational trapping is prohibited by the Act. • To improve the enforcement capability, it is recommended that the S 1/2 of Section 2 and NW Section 35 covered by the waters of David Lake are included in the ecological reserve by Order In Council.
6.1.5.2 Significant Features	• Undertake a breeding bird survey to monitor species and the variety of habitats used. • To monitor Cooper's hawk and sandhill crane use of the reserve. • To collect census and monitoring information on ungulate species to improve knowledge on habitat requirements and management.
6.1.5.3 Problem Wildlife Management	• The management committee to discuss problem wildlife and decide on what action, if any, should be taken. • Removal of any animal

	species, such as hunting or trapping, would be regulated by legislation including the WAERNA Act and the Wildlife Act. • The management committee will identify conditions and parameters within which wildlife species would pose a threat to rare and special species and habitats in the ecological reserve.
6.1.5.4 Invertebrate Pest and Disease Management	• The management committee to discuss problem pest(s) and/or types of disease and decide on the action, if any, that should be taken. Biological control methods should be used whenever possible. • Chemical pesticides should be used only when absolutely necessary and when there is no other alternative. If a pesticide is used, it should be target specific.
6.1.5.5 Species Re-Introduction	• The management committee would review any issues surrounding species re-introduction and decide what action, if any should be taken.
6.1.6 HISTORIC RESOURCE MANAGEMENT 6.1.6.3 Paleontological Resources	• To identify and protect significant historical resource sites. • To manage historical resource sites for scientific, educational and interpretive purposes.
6.1.6.4 Local Historical Resources	• The management committee collect additional historical information from families who lived in the area during the early "90's" These "pioneers" can provide important insights to present ecological

	conditions and assist in problem solving.
6.1.7 Visual Resource Management	• Aesthetic aspects of landscape management will be considered in all reclamation projects. • Placement and colour of fences and signs will be as unobtrusive as practical. • Existing fenceline clearings will be kept to a minimum width, as is practical. Fenceline clearings shall not exceed a maximum width of approximately 15 meters.
6.1.8 Oil and Gas Management	• Fences will be removed from around wells that have received a reclamation certificate. • The management committee will develop a contingency plan to deal with accidental spills or releases that may affect ecological resources inside the ecological reserve. • Using the existing trail under MSL 10342, Range Oil Ltd., may extract natural gas from the capped well in 07-15-42-05-W4M. The construction of a pipeline must follow the existing MSL trail and use methods that result in minimum disturbance such as "ploughing in line."Reclamation of MSL 10342 must, at a minimum, follow guidelines set out in subsections 6.1.4.4. and 6.1.4.5. Any methods used to remove gas from this capped well must use technology that does not require new dispositions.
6.2 Heritage Appreciation	• Request for environmental, education projects will be

	reviewed by the management committee to determine their compatibility with the purpose of the ecological reserve. An example of a possible compatibility would be a foot access only, non-destructive university research project that enhances the understanding of ecological processes at the reserve. • An information package will be developed describing the purpose of the reserve and state guidelines for its use.
6.3 OUTDOOR RECREATION 6.3.1 Access Management	• No motorized vehicles are allowed in the ecological reserve except for management purposes, i.e. grazing management, weed control, emergency service and enforcement. • For one half day in the spring and fall, Rutledge Ranches Ltd. have permission to move their livestock through the north east corner of the ecological reserve. This is a traditional and necessary access. The activity will be monitored to ensure it has no negative impact on the natural resources of the ecological reserve. • Foot access is encouraged whenever practical. • Signage to inform the public of access guidelines and restrictions will be displayed at all access points into the ecological reserve.
6.3.2 Enforcement	• Designated officer(s) to ensure motor vehicles are not used in the ecological reserve, unless approved for management purposes.

6.4 Tourism	• Tourism should be directed to other outdoor recreation and preservation areas in Alberta, i.e. provincial parks and recreation areas. • Tourism should not be promoted in the Wainwright Dunes Ecological Reserve. • Ecotourism (foot access only) for environmental education purposes will be reviewed by the management committee to determine compatibility with the purpose of the ecological reserve.
WAINWRIGHT DUNES ECOLOGICAL RESERVE Management Committee	• A key strategy to accomplishing the goals of the management plan is the development of a management committee. Responsibilities of this committee include assisting government to implement, monitor, evaluate and replan the management guidelines. Committee membership would assist of representatives from core government and non-government organizations. Benefits of this committee include proactive management and attainment of goals through the organized, cost sharing of people, resources, information and budget.

OTHER RECOMMENDATIONS

7.0 Buffer zones should be established between the reserve and Camp Wainwright, Buffalo Park Grazing Lease, and private landowners to minimize negative impacts inside the reserve. In addition, David Lake should be included within the legal boundary of the reserve.

8.0 Present study needs are:

(1) Maintaining some active sand dunes;
(2) Monitoring the rate of woody plant encroachment in grassland ecosystems;

(3) Monitoring the ecological condition of grazed versus non-grazed ecosystems;
(4) Ecosystem study of the large fen;
(5) Collecting ecological history from the landowners who live in the area.

9.0 Priority tasks to address include:

(1) information signage at the reserve;
(2) information brochure about the reserve;
(3) developing a management plan that deals with wildfire, fire suppression and prescribed burns;
(4) developing a monitoring plan including methodology, sampling techniques and procedures.

10.0 The management plan is to be reviewed annually by the Wainwright Dunes Management Committee to determine the need for plan amendments, changes, etc.

ACKNOWLEDGEMENTS

This plan was prepared by Marlene Krueckl and Julie Laux, Public Lands Branch. Dave Ealey, Environmental Protection, provided the editorial services.Dave Downing and Russ Wells, Resource Information Branch provided and coordinated the sandflat benchmark and vegetation assessment projects. Cliff Wallace who provided much of the biophysical information about the reserve. The core planning team members made this plan possible through information sharing, compromise and concensus.

APPROVAL STATEMENT

The Wainwright Ecological Reserve Management Plan is the official policy of the Government of Alberta for the management of this Ecological Reserve. The plan provides direction for management of the reserve that is consistent with the provisions of the Wilderness Areas, Ecological Reserves and Natural Areas Act. Approval of this plan reflects the Government's commitment to protect the ecological resources of this Ecological Reserve for present and future generations, while providing compatible research and educational opportunities.

M. Barrett
Assistant Deputy Minister
Natural Resources Service
Department of Environmental Protection

April 15/98
Date

L. Lyster
Assistant Deputy Minister
Field Services Sector
Department of Agriculture, Food and
and Rural Development

Apr. 14/98
Date

ENDORSEMENTS

Recognizing the value of the "Wainwright Dunes Ecological Reserve" for conservation purposes, as discussed in this document, we hereby endorse the Wainwright Dunes Ecological Reserve Management Plan as outlining the general policy and management intent for the site.

Gerry Ehlert, Chairman, Alberta Agriculture, Food and Rural Development	June 8, 1994 Date
J. Derek Johnson, Federation of Alberta Naturalists	March 15/94 Date
Allan Coleman, Alberta Fish and Game Association	March 1/94 Date
H. Ed Schaber, Fish and Wildlife Services	March 31/94 Date
Harry Loonen, Public Lands Branch	Feb 25/94 Date
Gary Walsh, Alberta Recreation & Parks	April 7, 1994 Date
Cliff Wallis , Alberta Wilderness Association	April 15, 1994 Date
Ralph Maull, Buffalo Park Grazing Association	March 5/94 Date
Morgan Fedak, Canadian Parks and Wilderness Society	Date
Helen Trefry, Wainwright Wildlife Conservation Society	28 Feb, 1994 Date

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APPENDICES

1.0 SCOPE OF THE PLAN

The Wainwright Dunes Ecological Reserve Management Plan provides the overall direction for the protection, management and operation of the reserve. It translates the provisions of the Wilderness Areas, Ecological Reserves and Natural Areas Act into specific guidelines to protect ecological values of the reserve. The plan is a commitment, by all involved, to the efficient and effective implementation of management guidelines. More specifically, the current plan accomplishes the following:

- assesses the biophysical resources and ecological values of the site;
- identifies information gaps and scientific research needs;
- reviews existing land uses;
- identifies management issues;
- establishes objectives for protection, heritage appreciation, outdoor recreation use and tourism promotion of the reserve;
- develops management guidelines and strategies to fulfil these objectives;
- prepares capital and operating budget estimates and establishes the administrative and support programs necessary to implement the plan;
- outlines monitoring strategies to evaluate the effectiveness of management of the reserve; and
- develops an implementation strategy that outlines the responsibilities and timelines of nongovernment agencies, government agencies and ranchers to carry out the management plan.

2.0 SYSTEM CONTEXT

2.1 Ecological Reserves in Alberta

2.1.1 Introduction

Ecological reserves are an integral part of Alberta's overall preservation/outdoor recreation system. Established under the Wilderness Areas, Ecological Reserves and Natural Areas Act, the Ecological Reserves Program is an interdepartmental endeavour.

Overall program coordination and legislative responsibility for ecological reserves rests with the Minister of Environmental Protection. On-site management of individual reserves is assigned to the most appropriate field agency, which depends on where the reserve is and where field

operations and local, available management expertise occur. In the Green Area, the management agency is typically the Land and Forest Services; in the White Area, Alberta Agriculture, Food and Rural Development, Public Lands; and in Special Areas, the Special Areas Board. If circumstances warrant, the management agency could be the Alberta Parks Services, Historic Sites or another agency, as appropriate.

Under Section 3.1(1) of the Wilderness Areas, Ecological Reserves and Natural Areas Act, public land may be designated as an ecological reserve if the area satisfies one of the following criteria:

"(a) is suitable for scientific research associated with the studies of natural ecosystems;
(b) is a representative example of a natural ecosystem in Alberta;
(c) serves as an example of an ecosystem that has been modified by man and that offers an opportunity to study the recovery of the ecosystem from that modification;
(d) contains rare or endangered native plants or animals that should be preserved; or
(e) contains unique or rare examples of natural biological or physical features."

Under Section 5 of the Act, programs may be carried out with the approval of the Minister,

"(a) for the management and preservation of the animal and plant life and the environment of the...ecological reserve,
(b) for environmental research that does not involve any physical disturbance of the...ecological reserve...,
(c) generally, for the preservation and protection of the... ecological reserve."

To further protect ecological reserves, the Act makes the provision for controlled buffer zones and sets out a number of prohibitions.

2.1.2 System Objectives

To clarify the role of ecological reserves in the overall preservation/outdoor recreation system, the Alberta Parks Services defines ecological reserves as "areas selected as representative or special natural landscapes and features of the province, which are protected as examples of functioning ecosystems, as gene pools for research, and for education and heritage appreciation purposes." This overall purpose statement is further refined in terms of the four broad program objectives of the Parks Services, that is: Protection, Heritage Appreciation, Outdoor Recreation and Tourism. These objectives are defined as follows, specifically as they relate to ecological reserves:

Protection: Protects a system of provincially significant, representative and special, natural ecosystems and features to ensure the perpetuation of genetic materials and natural ecological units.

Heritage Appreciation: Provides opportunities for unstructured exploration by individuals and for appreciation of the natural resource heritage of Alberta, in a manner compatible with protection of natural resource

features. Provides these opportunities through formal interpretation and education programs in some Ecological Reserves, where that is compatible with the protection of natural resource features.

Outdoor Recreation: Nonconsumptive, nature-oriented recreational use may be permitted subject to management guidelines.
Tourism: Protects ecologically based opportunities for visitors, subject to management guidelines.

The priority objective of ecological reserves is protection. Ecological reserves are legally established areas that protect our natural heritage, conserve biological resources and promote in situ conservation of species and ecosystems.

Ecological reserves allow ecosystems to maintain their natural processes in a relatively undisturbed state: they protect and maintain essential life-support systems.

A priority use of ecological reserves is for scientific research, which leads to the generation and dissemination of ecological knowledge. Reserves provide secure sites for both short- and long- term monitoring of environmental changes. They provide undisturbed sites for study of the natural environment's structure and function. Learning more about natural ecosystems will help solve many practical problems in resource management.

Ecological reserves also serve as benchmarks or ecological baseline areas against which the effectiveness of resource management practices may be compared.

Maintaining genetic resources, to benefit present and future generations, is an important role of the protection objective. Ecological reserves can help perpetuate gene pools as an invaluable source of new genetic material. The significance of such genetic material is demonstrated by their increasing scientific value for the development of new pharmaceuticals, for new varieties and strains of agricultural and forestry products, for pest control and for other products upon which the world's increasing human population depends. However, unlike zoos, gene banks, botanic gardens and other off-site protection mechanisms, ecological reserves enable these genetic resources to continue to evolve subject to naturally occurring environmental conditions.

Ecological reserves contribute to the heritage appreciation objective through interpretation, environmental education and the dissemination of information. Reserves provide environmental education opportunities for specialists, researchers, resource managers and the general public. These sites contribute to a heightened awareness and understanding of environmental matters. Visits to a site can contribute to this education, if such use is compatible with the protection objective of the specific reserve. In the broader sense, ecological reserves contribute through scientific research, demonstration projects and the dissemination of information through the formal and informal education system by way of publications and the media. Ecological reserves will contribute

significantly to better environmental understanding among Albertans. In this way, they will contribute to the achievement of provincial environmental quality objectives, better land use planning, more effective resource management and better overall environmental decisions.

Ecological reserves offer opportunities for outdoor recreation and environmentally oriented tourism that are compatible with the protection objective. As undisturbed natural landscapes, they are an expression of beauty, inspiration and spiritual value. As sanctuaries, they support the awe-inspiring myriad array of plants and animals in Alberta. They can express our desire to respect the rights of other life forms to exist.

Clearly, outdoor recreation, heritage appreciation and tourism are not priority objectives for ecological reserves. However, in many cases these areas are extremely attractive for such purposes. Subsequent sections of this plan refine the management parameters necessary to ensure that these uses are compatible with the overall protection objective.

2.1.3 System Framework

The target for the Ecological Reserves Program is to protect a system of significant representative and special landscapes and features that represent the full spectrum of environmental diversity of Alberta. The Natural Regions of Alberta provide the framework to identify and select ecological reserves. The six Natural Regions -- Grasslands, Parkland, Foothills, Boreal Forest, Rocky Mountains and Canadian Shield -- are distinctively different and readily recognized by the untrained observer. They are based on recurring, distinctive landscape patterns of vegetation, soils, landforms and, to a lesser degree, wildlife. The six natural regions are subdivided into 19 sections or biogeographical zones based on recurring and distinctive landscape patterns within each natural region. Recognition of the 19 biogeographical zones and their variability requires an understanding of the natural history of Alberta. Observable biological and physiographic features are the basis for identifying natural history themes within each of the biogeographical zones.

To protect the full spectrum of environmental diversity within the natural regions and biogeographical zones two subclasses of ecological reserves are used.

Representative Ecological Reserves contain examples of many of the ecosystem types of a particular biogeographical zone within the province.

Special Ecological Reserves contain unique or exceptional biological or geographical features, or offer the opportunity to study the recovery of an ecosystem modified by man.

When selecting representative ecological reserves an emphasis is placed on diversity. Attempts are made to include as many natural history themes as possible, as well as associated biological communities that exist in a particular biogeographical zone. Before a reserve is classified as representative, it must be decided whether the reserve is sufficiently

large, with sufficiently large communities to exist as self-functioning natural ecosystems. Once a reserve is classified as representative, the management plan focuses on strategies that permit ecosystems to continue to evolve in a largely unimpeded fashion. This approach, however, does not preclude management strategies that maintain special features within representative reserves.

Special ecological reserves are usually chosen for their unique character. In some instances, events leading to the establishment of a particular reserve may result in the designation of only a portion of a representative land base. If major ecosystems are no longer included or if they can no longer perpetuate themselves unaided, the site will be classified as a special ecological reserve. Once a reserve is classified as special, the management plan focuses on strategies that protect significant features and perpetuate special communities.

2.2 Role of Wainwright Dunes Ecological Reserve

The Wainwright Dunes Ecological Reserve is located within the Aspen Parkland Ecoregion, a unique ecoregion found only in the Prairie provinces of Canada. The reserve encompasses representative aspen and grassland communities, situated on sand dune and sand plain landscapes that are complexed with wetland and boreal forest ecosystems. Of special interest are the shrub wetlands and active/stabilized sand dune complexes that contain a diversity of plants and animals that are rare or at the limit of their range.

Wainwright Dunes Ecological Reserve is classified as a representative ecological reserve and its management plan focuses on strategies that protect ecological processes, natural resources and special features. These strategies will help perpetuate the biological diversity of the reserve including genetic, species and ecosystem elements.

3.0 OVERVIEW

3.1 Location and Regional Setting

The Wainwright Dunes Ecological Reserve is located in Twp 41-42, Rge 5, W4M, midway between the towns of Provost and Wainwright. Neighbouring the north boundary of the reserve is Department of National Defence (DND), Wainwright. Along the east and west sides lies public grazing land that is leased to Buffalo Park Grazing Association. David Lake (locally known as **Ray's Lake**) and privately owned grazing/agricultural/lands border the south boundary of the reserve.

3.2 Legal Status and Area

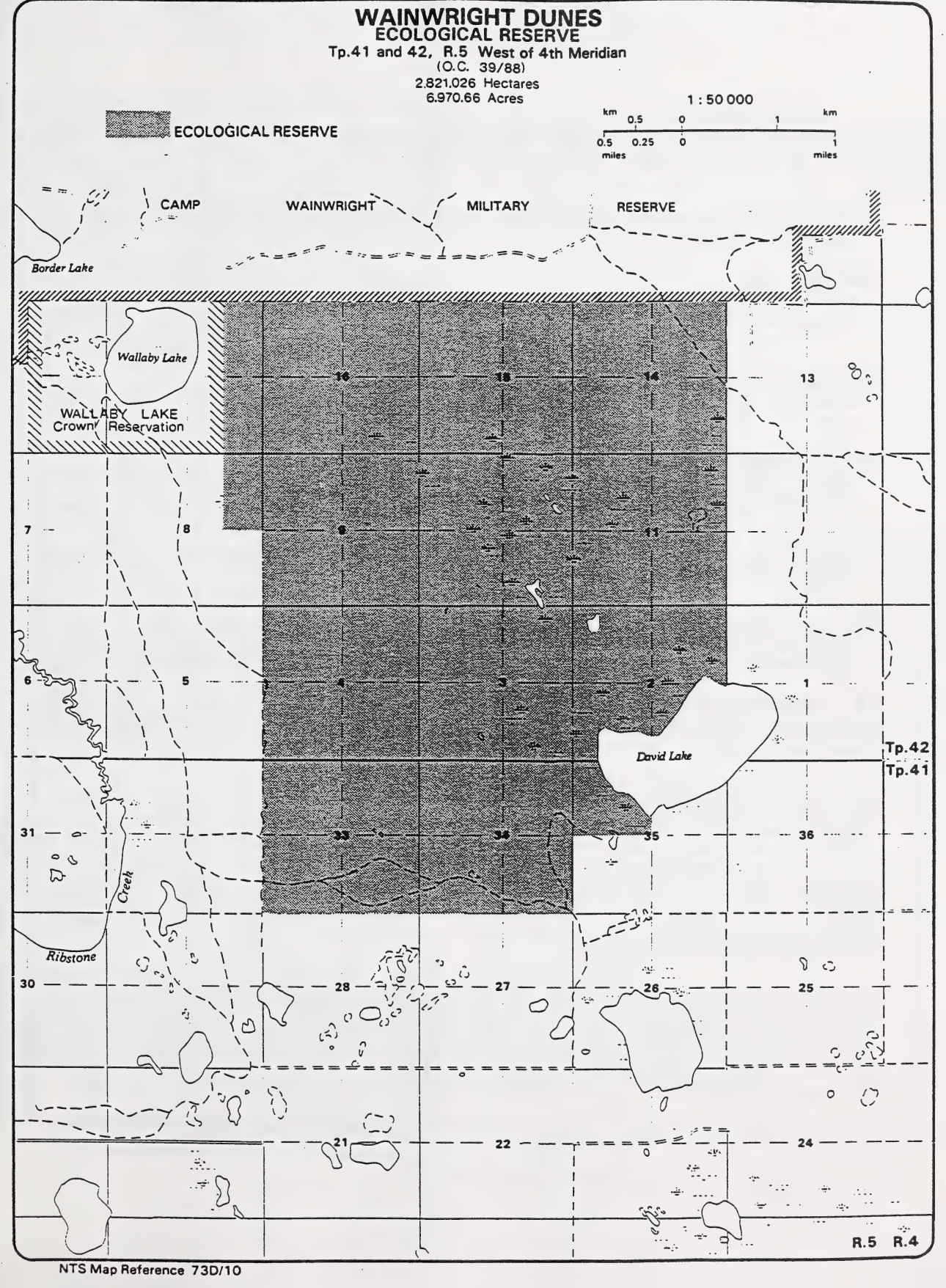
The Wainwright Dunes Ecological Reserve was established by Order In Council, January 14, 1988. The reserve covers a total area of approximately 2800 ha (6919 ac.).

3.3 Boundary, Definition and Justification

The Wainwright Dunes Ecological Reserve includes public land that is representative of the Aspen Parkland on sand dune/sand plain landforms, and is uniquely coupled with Boreal Wetlands. These ecosystems and special features remain in their natural state and are considered to be in good to excellent ecological condition. It is estimated that only 5 percent of the Aspen Parkland has not been cleared and cultivated. There is presently poor representation of the parkland in federal and provincial "protected area" systems. The boundaries of this reserve encompass an extensive area of Parkland in its natural state.

WAINWRIGHT DUNES
ECOLOGICAL RESERVE

Tp.41 and 42, R.5 West of 4th Meridian
(O.C. 39/88)
2,821.026 Hectares
6,970.66 Acres



NTS Map Reference 73D/10

3.4 Reserve History

The following is a brief overview of events leading to the establishment of the Wainwright Dunes Ecological Reserve:

April 1981
Wainwright Dunes is identified as a potential candidate for ecological reserve status.

November 1984
The Ecological Reserve Steering Committee proposed the designation of 14 ecological reserves, representing ecological regions and subregions of Alberta

September 1986
Government meetings held with lessees in proposed ecological reserve area.

October 1986
Public meeting held at Provost to obtain input from the public and interest groups.

January 14, 1988
Wainwright Dunes Ecological Reserve established by Order In Council (39/88)

July 10, 1991
Core and Consultative Planning Team initiated to develop a draft management plan for the Wainwright Dunes Ecological Reserve.

3.5 Resource Information

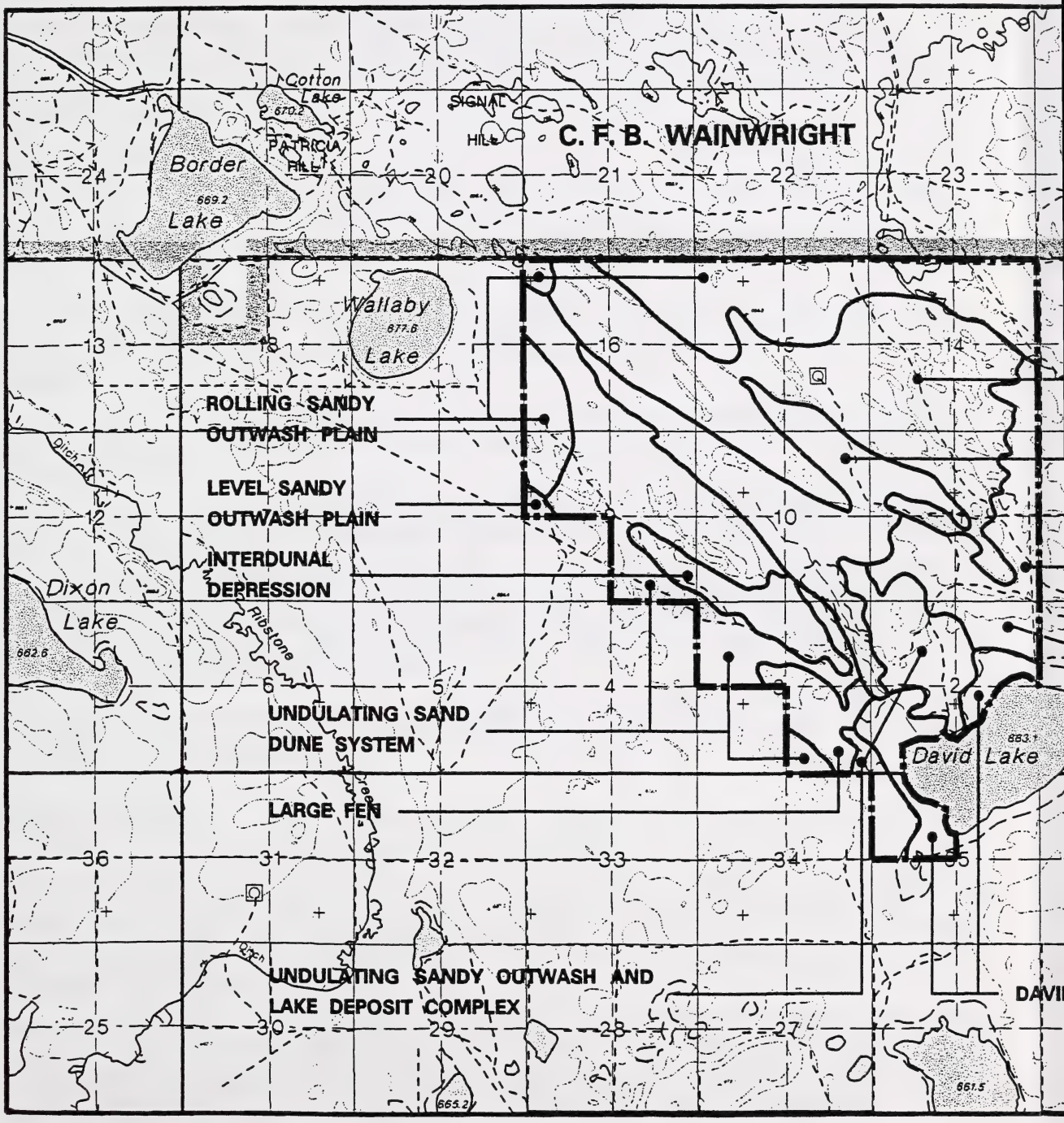
This section is based on the biophysical overview in Cottonwood Consultants Ltd. (1986).

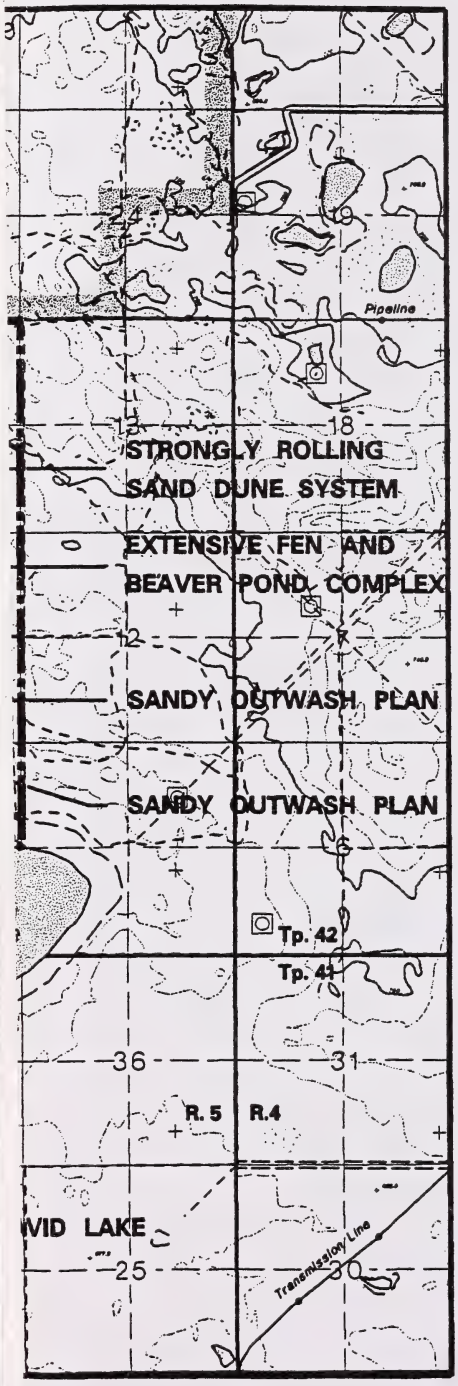
3.5.1 Geology and Landforms

The entire Wainwright area was glaciated; consequently, most of the surface materials were deposited by glacial meltwaters. The resulting sandy terrain was subjected to northwesterly winds over an extended period and a large complex of parabolic-shaped dunes formed. Erosion of the southern parts of the dunes left a parallel series of sandy ridges which persist today over much of the area. These have been described as sand dunes of the "North Battleford" type. Active blowouts are scattered throughout the dune system.

Sandy areas known as outwash plains, which are more level, occur along the northern and western boundaries of the reserve and in the vicinity of David Lake. Outwash along the north boundary may have been reworked by wind, which has produced more topographic relief than found in the level outwash plains along the Ribstone Creek valley and David Lake. Gravels are locally present in the western portion of the reserve.

A hilly landform type, known as kame moraine, just barely enters the


C. F. B. WAINWRIGHT
Cotton Lake
670.2
SIGNAL HILL
PATRICIA HILL
Border Lake
669.2
Wallaby Lake
677.6
ROLLING SANDY OUTWASH PLAIN
LEVEL SANDY OUTWASH PLAIN
INTERDUNAL DEPRESSION
Dixon Lake
662.6
Ribstone Creek
UNDULATING SAND DUNE SYSTEM
LARGE FEN
David Lake
683.1
UNDULATING SANDY OUTWASH AND LAKE DEPOSIT COMPLEX
665.2
661.5



WAINWRIGHT

CANDIDATE ECOLOGICAL RESERVE

Tp. 41 and 42 – R. 5 W4

LANDSCAPE UNITS

SCALE 1:50 000

Legend

STUDY AREA BOUNDARY

reserve in the extreme northeast corner. This feature was formed by meltwater at the edge of the melting ice. All of these sandy landforms are part of the most extensive sand plain in the Central Parkland. Recent deposits containing finer materials are found in and around David Lake and in the wetlands that occur between the dunes. A thick layer of decomposing organic matter has developed in the more extensive of these interdunal wetlands

3.5.2 Soils

Wainwright lies within the Dark Brown soil zone. However, reworking of the sand by wind has resulted in weak development of soil profiles over much of the area. While typical of Central Parkland sandy terrain, soils of the Wainwright area are generally not typical Dark Brown Chernozem soils.

The soil of the dunes has a high sand content and very little organic content and structure. Described as Regosols and weak Chernozems, these are well-drained and susceptible to erosion if their vegetative cover is removed.

Organic soils with a deep layer of decomposing plant material are found in the larger shrub wetlands. In some areas, the depth of the organic layer exceeds 1 m.

In the meadows and marshes around David Lake and in moist depressions, finer-textured and water-saturated soils known as Gleysols have developed.

Sandy-textured Dark Brown Chernozem soils are found in the outwash and kame moraine areas under aspen, shrub and grassland vegetation. Dark Brown Chernozems in the David Lake area have a "gleyed" appearance from previous inundation by lake waters. They tend to be loamy because of the addition of finer silts and clays.

Dark Gray Chernozems, indicating a longer-term presence of woodland, may be found under some of the established aspen and balsam poplar stands in the vicinity of David Lake.

3.5.3 Climate

Strong and Leggat (1981) described the climate of the Aspen Parkland as a mixture of boreal and prairie weather components. Mean yearly precipitation is 450 mm (18 in.) with a range from 390 mm (15 in.) to 710 mm (28 in.) at Camrose and Mountain View-Birdseye, respectively. Mean yearly precipitation is 70 mm (3 in.) less than the Fescue Grass and 50 mm (2 in.) more than the Mixed Grass ecoregions. Available moisture during July to September may be important to the survival of aspen clones in the parkland environment.

Temperatures show a continental influence including large yearly and daily ranges. Mean winter temperatures are lower in the Aspen Parkland compared to the Fescue Grass or Mixed Grass ecoregions. An average of fewer than 15 chinooks per winter occur in the Aspen Parkland, which contributes to lasting snow cover and increased snow depth compared to grassland

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ecoregions.

Information is available from seven weather stations operated within a 32 km (20 mi.) radius of the ecological reserve. Average annual precipitation at these sites ranges from 364 mm (14.3 in.) at Chauvin to 441.5 mm (17.4 in.) at Amisk. The higher precipitation values generally occur north or west of the ecological reserve, and lower values, south or east of the reserve. Data on the frost-free period are available for four sites within the 32 km radius. Average annual frost-free period has been 97 days at Hughenden to 118 days at Horseshoe Lake. This period is from about the first of June through the first week of September.

3.5.4 Physiography and Hydrology

Wainwright is part of a gently rolling sandy plain on which there are numerous sand dunes. The dunes are fairly closely aligned in parallel ridges oriented in a northwest to southeast direction. Some of the dunes are steep-sided and up to 30 m in height. The higher dunes offer superb views of the rolling landscape.

As in most Central Parkland areas, there is very little overall topographic relief. The highest point, 720 m above sea level (masl), lies in the extreme northeast corner while the lowest point is David Lake at 657 masl. The greatest local relief occurs in the sand dune areas, while the most level topography lies along the western edge and in the south adjacent David Lake.

Groundwater is at or near the surface in many interdunal areas and on the slope north of David Lake. Springs feed the large wetland complex northwest of David Lake and a unique slope wetland to the north of the lake. The area drains into David Lake by a complex of wetlands, small streams and groundwater flow. Outlet water from David Lake flows underground, south to Black Creek and outside the proposed ecological reserve. This creek ties into the North Saskatchewan River drainage through Ribstone Creek and the Battle River.

Water levels fluctuate greatly in David Lake. The aerial photographs from 1949 show the lake completely dry. In the past 10 years, water levels have tended to be low but the lake has not completely dried up. Levels in 1986 appeared to be slightly higher than usual, as a result of increased summer precipitation. In 1992, David Lake was dry.

3.5.5 Plants

The variety of landforms and hydrological features is reflected in the diversity of plant communities and in the richness of the flora. Over 300 types of native vascular plants and 80 kinds of lichens and mosses have been identified from the Wainwright area. Of the 112 plant species considered typical of aspen and poplar woodlands and occurring in the Central Parkland region, 105 can be found within the boundaries of the proposed ecological reserve.

The vegetation of the area is unique in Alberta because significant numbers of both southern grassland and northern boreal forest plants

occur, in addition to the typical parkland species. Many of the boreal forest species occur in the wetland systems and more mature poplar woodland while the grassland types occur in the open grassy areas and open dune areas.

Aspen and balsam poplar woodlands have increased markedly since the turn of the century and now occupy about 40 percent of the area (Cottonwood Consultants Ltd. 1986). Shrubland and grassland also represent 40% of the total area. A variety of wetlands make up the remaining 20% of the vegetation.

Descriptions of the Central Parkland made during the early part of this century may have been of an "atypical" landscape, extensively and recently burned because of natural and man-related factors. Drought in the 1890s, construction of the railroads, and expansion of settlement all led to widespread burning and elimination of woody vegetation.

Under "natural" conditions, the grassland may never have been as extensive as that noted by early settlers. However, modern fire control may have allowed the forest vegetation to spread more widely than it formerly would have. Fire was a very important factor in preventing expansion of the forested area into grass and shrub communities. In very dry periods, frequent fires undoubtedly burned much of the region, resulting in extensive elimination of clones and rejuvenation of wetlands. Grazing by bison in the Central Parkland does not appear to have been as important in maintaining the native vegetation as it was in the Mixed Grassland further south. Most historical and recent scientific accounts indicate there would have been light and seasonal grazing use of these areas.

Many plants typical of the native grasslands of the Aspen Parkland are reduced or eliminated under heavy grazing pressures and are replaced by plants that are more characteristic of the Mixed Grass Prairie. For example, heavy and continuous grazing will cause the disappearance of rough fescue and western porcupine grass and cause conditions for replacement by shallower rooted plants such as June grass and everlasting.

The following are the major vegetation types at Wainwright, arranged in approximate order from driest to wettest.

1. Sand Dunes

Plant communities of the sand dunes are a mixture of stunted aspen groves, low shrubbery, grasslands and open, actively eroding areas called blowouts. The woodlands and grasslands tend to be drier and more open than their non-dune counterparts. The plant communities are unique to dune areas and there are many species that do not occur in other habitats.

Colonization of the active blowouts begins with sedges and grasses and is followed by the growth of lichens, creeping juniper and forbs. Active blowouts have very few types of plants and are mostly open sand. Hay sedge, sand grass, sand dropseed, Canada wild rye, Indian rice grass and creeping juniper are the most common species but their cover is low.

Stabilized blowouts are areas that have recently been eroding but are now stabilized with plant cover. As a result, they contain a greater number of plant species. A variety of lichens, including reindeer lichen and lichens of the genus Cetraria, make up a large part of the cover. Principal vascular plants are sand grass, hay sedge, Rocky Mountain fescue, prairie selaginella and creeping juniper. The interfingering of dark green juniper plants into the lichen mats creates colourful and interesting patterns that are a very distinctive aspect of sandy lands in the Central Parkland.

Some of the most significant species at Wainwright are found in the blowouts: sand heather, annual skeletonweed, sand sedge and sand nut-grass. Sand nut-grass and sand sedge appear to be absent from heavily grazed active blowout areas in the northeast.
On the south side of stabilized dune ridges, grasses are prevalent. These grasses include bearded wheat grass, sand grass, Canada wild rye, rough fescue, June grass and western porcupine grass. Mat muhly thrives in the interdunal flats. Lichens carpet many locations and there are scattered, low choke cherry plants, wild rose, junipers and bearberry. A variety of flowering plants, including many Mixed Grassland species, occur here: plains wormwood, pasture sage wort, prairie sage wort, chamaerhodos, golden aster, prairie rocket, skeletonweed, prairie selaginella, golden bean and locally, brittle prickly-pear. Poison ivy is often abundant in the edge habitat between the open dune slopes and the more heavily treed sides.

The low areas between the dunes have more well-developed vegetation composed of scrubby aspen, tall and low shrubs, grassy areas and lichen-juniper mats. Taller shrubs often occur in small clumps and may include water birch, beaked willow, silverberry, saskatoon and choke cherry.

The stunted aspen groves are drier, often with a denser cover of sedges and grasses and with fewer and sparser shrubs and forbs, than the well-developed aspen stands that occur on moister sites. The aspen rarely forms a closed canopy and is often less than 2 m in height. Common plants in the understory include silvertop sedge, golden bean, northern bedstraw, buckbrush, wild rose, choke cherry, narrow-leaved meadowsweet, yellow peavine and star-flowered Solomon's-seal.

On the protected, northeast-facing dune slopes, there are closed stands of woody plants ranging from aspen woods to thickets of low rose and buckbrush or taller choke cherry and saskatoon. The aspen woods are very similar to the drier woods of non-dune areas.

2. Grasslands

Grasslands are widespread, occurring on a variety of landforms and varying considerably in their composition. Dominant grasses include representatives of the Aspen Parkland Ecoregion. Grazing has affected most of the grasslands and the composition shifts in response to grazing pressure and climatic changes. Currently, the western part of the area

receives the least grazing pressure, while the area around David Lake is the most heavily used.

The previously described dune grassland is the driest and most widespread type. On lightly grazed, more level outwash plains, the grasslands are lusher and are dominated by low sedges, western porcupine grass, needle and thread, and june grass. Other leading grasses are sheep fescue, interior bluegrass, rough fescue, sand grass, wheat grasses, and Hooker's oat grass. The principal flowering plants are crocus, pale comandra, three-flowered avens, bluebell, late yellow locoweed, golden bean, mouse-ear chickweed and woolly cinquefoil. The woody plants found scattered through the grassland include rose, creeping juniper and choke cherry. As grazing pressure is reduced on those portions of the grassland that have received heavier use, there will likely be an increase of rough fescue and plants commonly associated with rough fescue grassland. The droughty, sand nature of the soil will not change and some species such as sand grass and Rocky Mountain fescue will maintain a higher cover than is found when soils are not as coarse.

Grassland in the extreme northeast on the kame moraine is dominated by June grass, low sedges, low everlasting, needle and thread, prairie sage wort, and Prairie selaginella. Under lighter grazing conditions, this area would show an increase in climax grass species associated with rough fescue, such as bearded wheat grass, and western porcupine grass. The variety of fescue grassland flowers would also increase.

Grasslands in the David Lake area are more moist and calcareous than other grasslands and they have also been very heavily grazed. These factors are reflected in the absence of many fescue grassland species. Dominant plants include low everlasting which grows in semi-continuous carpets as well as sedges, bluegrasses, mat muhly, wire rush, June grass and pasture sage. Areas that are not so heavily grazed have a significantly higher cover of western porcupine grass and bearded wheat grass.

3. Low Shrubbery

Spread throughout the grasslands are dense buckbrush and silverberry thickets. These are particularly extensive in the grasslands in the vicinity of David Lake. Typical species in the buckbrush are wild roses, yarrow, June grass, prairie sage, graceful sedge, bearded wheat grass, smooth aster, interior bluegrass and western porcupine grass.

The silverberry stands situated in the David Lake area have a relatively open growth of silverberry with a dense understory of buckbrush and wild rose. Wild gooseberry is prevalent in some stands. Many of the grasses and forbs growing in buckbrush thickets also occur in silverberry stands.

4. Aspen Woodland

Groves of aspen grow in depressions and on the north- and east- facing slopes of dunes and hills. Most have a lush cover of shrubs and flowering plants. Low shrubs such as choke cherry, buckbrush and wild rose

predominate. Other major plants include narrow-leaved meadowsweet, purple oat grass, pin cherry, yellow peavine, northern bedstraw, wild strawberry, star-flowered Solomon's-seal and veiny meadow rue. Poison ivy is locally abundant in the dune area woods. Rarer plants in the sand dune aspen are long-leaved bluets and dwarf milkweed.

In moister depressions and non-dune areas, aspen woodlands grow to their greatest height (15 m) and develop several layers of shrubs and a great variety of typical woodland forbs. Major species of these moister woodlands include chokecherry, saskatoon, beaked hazelnut, red-osier dogwood, wild red raspberry and snowberry. Silverberry is locally important in the northeastern and far western portions. Some of the characteristic flowering plants are northern bedstraw, pink wintergreen, dewberry, veiny meadow rue and western Canada violet. Beaked willow is often found scattered throughout these woods.

5. Balsam Poplar Woodland

Balsam poplar woodland is more restricted in distribution than aspen woodland and has a moist, dense understory of medium-sized shrubs and lush forb layers. Poplars up to 20 m in height and 30 cm in diameter have been recorded here. Poplar stands are found immediately adjacent fens and tall willow stands and along the north shore of David Lake where groundwater appears close to or at the surface. White birch is often present in these woodlands along the edges of the fens--some grow to a height of 13 m and a diameter of 24 cm.

Major plants in the rich ground cover are red-osier dogwood, beaked hazelnut, high-bush cranberry, wild rose, snowberry, wild sarsaparilla, veiny meadow rue, dewberry and Lindley's aster. As in the moister of the aspen woods, forbs are common. Among the flowers in the lush green layers are wild strawberry, bunchberry, bishop's cap, twinflower, baneberry, northern bedstraw, veiny meadow rue, wild lily-of-the-valley, snakeroot, sweet-scented bedstraw, blunt-fruited sweet cicely, star-flowered Solomon's-seal, fairy-bells and wild vetch. The high-bush cranberry is characteristic of these woodlands.

6. Willow Shrubbery

Dense tall willow stands ring many of the moist depressions and larger wetlands. They also occur on hummocks within the larger fens. During dry years, the willows encroach on the wetlands; while in wet years, the spread of willows is kept in check by the drowning of saplings. They vary from impenetrable tangles to fairly open stands with few species in the ground cover.

Water occurs at or above the surface in many of these stands. Important willow species include MacCalla, blueberry, basket and tea-leaved willows. Other locally important shrubs are pussy willow, Bebb willow, red-osier dogwood and dwarf birch.

The understory is quite variable, depending on the extent of recent flooding. In many stands, it is made up of marsh reed grass, palmate-leaved coltsfoot, Canada anemone, pink wintergreen, dewberry, sweet-scented bedstraw, bog violet and yellow avens. Water parsnip, common skullcap, wild mint, hedge nettle, common nettle, tufted loosestrife, water-horehound, bulb-bearing water hemlock and a variety of sedges form distinctive communities in wetter sites. Mosses form a significant part of the ground cover in several stands.

Rare plants of the ecological reserve include two orchids: spotted coralroot and yellow lady's-slipper. These plants are found in willow stands adjacent to major fens.

7. Moist Meadows

Open moist meadows occur adjacent David Lake and along drainages between the lake and the fen/beaver pond complex.

Less saline meadow areas away from the lake and along its north shore have a high proportion of grasses and grass-like plants. Major species include northern reed grass, tufted hair grass, bluegrasses, wire rush, spike-rushes and silverweed. In some areas, willows appear to be invading the wet meadow areas. Distinctive plants of the moist meadow/grassland edges are blue-eyed grass, western wood lily, short-stemmed thistle and meadow blazingstar. The rare moss gentian grows on hummocks in the moist meadows near David Lake.

In some moist areas along the shore of David Lake, groundwater discharge and fluctuating lake levels have made the soil saline. Many of the saline meadows have a higher cover of broad-leaved plants than do non-saline areas. Silverweed, salt grass, sea milkwort, foxtail, marsh ragwort and salt meadow-grass are important. Three-square bulrush forms extensive stands along the south shore of David Lake. Other indicators of the saline conditions are creeping buttercup, shooting star, samphire and sea blite.

8. Fens

The fens of the ecological reserve are relatively open wetlands dominated by sedges, grasses and low shrubs. The fens located at Wainwright are unusually extensive for the Central Parkland and are the southernmost fens in eastern Alberta. They occur between the sand dune ridges and are often associated with beaver activity.

The fens are characterized by a well-developed low shrub layer of dwarf birch and willows. Patterning is evident in two of the larger fens northwest of David Lake. This patterning consists of raised ridges known as strings that alternate with water-filled depressions known as flarks. High hummocks within the fens support tall willow stands and some trees. The higher plants and mosses both indicate mineral-rich fen conditions.

A rare fen type occurs on the slope north of David Lake. Here, groundwater flowing down a hillside has resulted in the formation of a slope fen.

Dwarf birch is the dominant shrub and forms a fairly dense cover over most of the fen areas including the strings in patterned areas. Other important shrubs are hoary willow, autumn willow and tea-leaved willow. Leading non-woody plants are water sedge, inland sedge, beaked sedge, buckbean, marsh reed grass, bog muhly, white camas, bog violet and marsh cinquefoil. The major brown moss on the strings and throughout much of the fen vegetation is Tomenthypnum nitens. Peat mosses are locally abundant on hummocks.

Major flark species are two-stamened sedge, shore sedge, swamp horsetail, buckbean, bog willow and seaside arrow-grass. Brown mosses of the genus Drepanocladus predominate. Other flark species include water sedge, slender sedge, thin-leaved cotton grass, elephant's-head and sticky asphodel. Two types of sundew and flat-leaved bladderwort are also present in some flarks.

A high proportion of the rarer plants in the Wainwright area are found in the fens. Many of the boreal-cordilleran and boreal plant species discussed under "Significant Features" occur in the fens and immediately adjacent wet tall willow stands.

9. Marshes and Open Water

Open water is present in David Lake and several beaver ponds. These water bodies are ringed with marshes composed of sedges, bulrushes, manna grasses, cattails and numerous other aquatic plants.

The largest marshes and open water system occurs at David Lake. Here, there are extensive beds of bulrushes and submergent aquatic vegetation. Two types of pondweed and the rare wigeon-grass have been recorded here.

Extensive sedge marsh occurs in the shallower water adjacent the bulrush marsh. In addition to beaked, water and Parry sedges, important species include northern reed grass and manna grass. The sedge meadows are particularly extensive along the west side of David Lake. They intergrade into the adjacent moist meadows.

Beaver ponds have the richest aquatic plant communities. Floating plants of open water include broad-leaved water-plantain, mare's-tail, duckweeds, white water crowfoot, yellow water crowfoot, arrowhead and bur-reeds. Submergents in the beaver ponds include six species of pondweed, horned pondweed, water milfoil and common bladderwort. The uncommon flat-stemmed pondweed occurs in the large beaver pond northwest of David Lake.

A number of plants are encountered mainly in the shaded and moist conditions found at the edge of beaver ponds. These include water

parsnip, willowherb, common skullcap, small-fruited bulrush, nodding beggarticks, reed canary grass and agrimony.

3.5.6 Animals

Wainwright Dunes Ecological Reserve is endowed with an intriguing variety of wildlife habitats. These include complex sand dune terrain, grasslands, dry low shrubbery, aspen and balsam poplar woodland, moist shrublands, marshes and open water. Combined with the natural habitats on Department of National Defence (DND), Wainwright block to the north and some immediately surrounding land to the south and west, the Wainwright area forms an extensive, relatively natural, block of wildlife habitat. Ongoing habitat destruction in the Central Parkland, including land immediately adjacent the ecological reserve, makes the natural habitats here increasingly important as a refuge for wild animals.

While detailed field investigations have not been carried out on all groups of wildlife, analysis of the bird life shows that the area is quite representative of the Central Parkland, particularly for the woodland species. Of 124 native bird species which regularly nest in this natural region, about 100 nest in the Wainwright area.

A few species like the coyote and deer mouse are wide-ranging through several habitat types but most have narrower and, in some cases, very specific habitat requirements.

The following habitats are arranged in approximate order from driest to wettest.

1. Grasslands and Dry Shrubbery

Only a small number of animal species use the grassland and dry shrubbery, but the grassy areas at shrub and woodland edge in the dune complex are very important for animals like the mule deer, thirteen-lined ground squirrel, and sharp-tailed grouse. Though rare, lark sparrows are also found in this habitat. Common nighthawks nest on the drier dune ridges but feed widely over the area.

Savannah sparrows frequent the lusher grasslands on level outwash plains and along the shore of David Lake.

Low buckbrush and rose thickets are well used by vesper sparrows, while taller saskatoon and silverberry stands support American goldfinches and yellow warblers. Clay-colored sparrows are common in all types of shrubbery.

2. Woodland

The woodlands support a rich bird life because of the plentiful feeding opportunities created in the many layers of lush vegetation. Drier woodlands tend to have the least number of species while moist aspen and

balsam poplar stands are some of the most significant bird habitats in the region. A small number of amphibian and mammal species are also found in these habitats.

Wildlife that occupy a broad range of woodland types are the chipping sparrow, dark-eyed junco, red-eyed vireo, black-capped chickadee, mountain bluebird, downy woodpecker, least flycatcher, mourning dove, American robin, American goldfinch, yellow warbler, red-tailed hawk, American crow, black-billed magpie, and least chipmunk.

Hermit thrushes prefer the drier woodland of the dune complex. Rare birds in the dunes are the merlin and sharp-shinned hawk.

In the lusher aspen and balsam poplar woods, the bird chorus is often rich and varied. In addition to the wide-ranging woodland species, birds nesting here include the American redstart, hairy woodpecker, northern oriole, ovenbird, veery, house wren, great horned owl, warbling vireo, ruffed grouse and rose-breasted Grosbeak. Significant species, often found in the more diverse woods adjacent the fens, are the red squirrel, broad-winged hawk, northern saw-whet owl, ruby-throated hummingbird, blue jay, yellow-bellied sapsucker, black-billed cuckoo, northern goshawk, and Cooper's hawk.

White-tailed deer are most commonly seen in the non-dune woodlands and the grasslands associated with the outwash plains and kame moraine areas.

3. Moist Shrublands

The moist tall willow thickets are one of the three most significant bird habitats at the ecological reserve. As in the marshes and moist woodlands, there are high populations and a diversity of species, including several of the rarer birds. Species nesting here are the American redstart, cedar waxwing, alder flycatcher, white-throated sparrow, eastern kingbird, yellow warbler, Tennessee warbler and veery. Orange-crowned warblers occur in this habitat and in scattered water birch and tall shrubs in the dune complex. The black-and-white warbler, normally a boreal forest species, nests and feeds in the large willows along the margins of the extensive fen systems. Snowshoe hares dwell in the moist shrub/woodland edges. Moose are also present in these habitats.

Song sparrows are most common in tall shrubbery next to open water such as that around the beaver ponds and David Lake.

Inhabitants of the dwarf birch fens are the Lincoln's sparrow. clay-colored sparrow, lesser yellowlegs, common yellowthroat, and two amphibians - the Canadian toad and wood frog. The last two species also range into adjacent moist shrubbery and woodlands.

4. Marshes and Open Water

Water bodies are rich in bird life and many of those at Wainwright Dunes Ecological Reserve are maintained by beaver activity. Significant numbers

of waterfowl are attracted to these areas during the migration and nesting seasons.

Many of the principal bird species of the Central Parkland wetlands are found at the ecological reserve. These range from rails, terns, grebes, geese and ducks to smaller songbirds such as marsh wrens, blackbirds and sparrows. Significant wetland birds that have not yet been noted at the ecological reserve include the yellow rail, sedge wren, and bobolink, which nest along the Ribstone Creek marsh system just west of the area.

Some of the birds associated with open wetlands, and that have more widespread distributions, include the common yellowthroat, red-winged blackbird, northern shoveler, Wilson's phalarope, American coot, sora, blue-winged teal, lesser scaup, green-winged teal and mallard. Wood frogs breed in the wooded ponds, while Canadian toads and boreal chorus frogs breed in a variety of wetlands. Tree swallows feed widely throughout the wetland areas but nest in adjacent woods. Buffleheads feed in beaver ponds around which there are suitable nesting trees.

The marshes of David Lake and the large beaver pond attract a broad assortment of diving and puddle ducks. Other birds using the David Lake area include Canada geese, yellow-headed blackbirds, redheads, marsh wrens, red-necked grebes, pied-billed grebes and eared grebes.

Sandhill cranes migrate through the area and they may still nest in suitable habitat in the fens. Adult cranes have been seen during the summer in several years at David Lake. These birds are sensitive to disturbance during the nesting season and require extensive areas of isolated natural habitat. Sandhill cranes have been recorded nesting at Dudgeon Lake.

Open shorelines along David Lake provide loafing areas for diving and puddle ducks and nesting sites for several shorebirds including the American avocet, killdeer, willet, marbled godwit and spotted sandpiper. These areas are also favored by a variety of shorebirds migrating to and from their more northern nesting grounds. Plains garter snakes live in these habitats.

The extensive sedge marshes and moist meadows at the west end of David Lake provide nesting and feeding habitat for birds like the common snipe, Le Conte's sparrow, savannah sparrow and the rarer sharp-tailed sparrow.

Butterfly populations are most plentiful and varied in open parts of the fens and in more lightly grazed moist meadow/grassland edges between David Lake and the large beaver pond complex.

3.5.7 Visual Landscape

From the northeast corner of the ecological reserve, an unbroken view of undulating sand dunes, beaver ponds, shrub fens, and woodlands can be appreciated. Aesthetic values are many and include the patchwork of riparian, parkland and sand dune plant communities. The ecological reserve provides many examples of nature's fragility and strengths such as

the yellow lady's-slipper, the battles between wind and sand, the courting of tree swallows, the succession of western porcupine grass onto a disturbed site, and a doe and fawn white-tailed deer browsing while under the scrutiny of a coyote. People benefits include appreciating the tonic of wilderness present in the ecological reserve.

The DND, Wainwright lands located on the north boundary of the ecological reserve, has on its west side open grasslands (native and tame pasture) with little sand dune areas. These areas enhance the natural character of the reserve by providing a visual buffer. The beaver ponds and David Lake's moist and wet environments also enhance and contrast the aesthetic values of the many dry environments of the reserve.

3.5.8 Paleontology and Archaeology

Paleontology

The reserve is in an area with unknown potential according to the Tyrrell Museum of Paleontology's Resource Sensitive Zones Map. The area has not been surveyed, so Quaternary resources, e.g., fossilized mammalian remains, are unknown at this time.

Archaeology

Previous research in this region of the province indicates it was well used in prehistoric times. The cultural history of the area began about 11 000 years ago and extends consistently through the Early Transitional, Middle and Late Prehistoric Periods. While no sites have been identified in the planning area to date, the area is considered to have high potential for site discovery. Sites are likely to be found in areas associated with sheltered, well-drained south-facing situations or close to both present and past sources of water.

3.5.9 Special Features Summary

Most of the Wainwright Dunes Ecological Reserve could be classed as significant. There are major landscape, hydrological, vegetation and wildlife features in virtually every corner of the proposed ecological reserve. The entire area could be classified as provincially significant and, when considered in the context of the larger natural parkland area of the surrounding lands, it is probably of international stature.

Overall, two of the most outstanding landscape units are the dune system and the fen and beaver pond complex. The dune system is an impressive representative of the sand dune terrain and life of the Central Parkland. The fen and beaver pond complex is a major hydrological feature that supports a wide array of plants and animals.
The diversity of habitats is remarkable for such a small area of the Central Parkland. This diversity is reflected particularly well in the variety of plants and birds. The productive bird habitats are the marshes, tall willow thickets and more mature poplar woodlands. Ranging out from the Canadian Forces Camp Wainwright block is a sizeable deer population, which includes both mule and white-tailed deer. The mosaic of grassland, shrubbery and woodland provides ideal food and cover.

Another major feature is the presence of a large number of rare or unusual

species, particularly in the larger fen and active dune areas. Because of the localized nature of many significant plants and animals, there is a high probability that further research will uncover additional rare species in the wetland dune systems.

Three areas are of particular note for the rarest plants:

1. The lightly grazed active blowouts in the southwest corner, where one of only two Alberta populations of sand nut-grass occurs.

2. The moist meadows west of David Lake, where moss gentian grows.

3. The central part of the large fen, which supports a population of slender-leaved sundews.

Uncommon in Alberta, the slope fen north of David Lake constitutes one of the rarer biophysical units found at the ecological reserve. Associated with it are several significant plants and animals.

3.6 Land Use

3.6.1 Dispositions

Grazing

The area covered by Wainwright Dunes Ecological Reserve has been grazed by horses and cattle since approximately 1905 when the first homesteaders arrived. Since 1948, all the area in the reserve has been grazed by under management of the Buffalo Park Grazing Association, under Public Lands Division Grazing Lease 38839.

Subsurface Petroleum and Natural Gas Leases are held in NW and E of Section 3, Section 10, and Section 15, Township 42, Range 5, and in the NW of 35, Township 41, Range 5.

Petroleum and Natural Gas

Industry has been interested in petroleum and natural gas resources of the reserve area for several decades. This has resulted in four seismic exploration lines totalling approximately 15 km, several kilometres of new or partially upgraded vehicle trails and seven wells. The only well to encounter reserves of natural gas is in Section 15 (7-15-42-5-W4M), and is currently capped. Other wells have been drilled and abandoned in Sections 3, 9, 14 and 15 of 42-5-W4M and also Sections 33 and 35 of 41-5-W4M.

Subsurface mineral rights are disposed by means of five petroleum and natural gas leases in Sections 35 of 41-5-W4M and in Sections 8, 10, 15, 16 and 17 of 42-5-W4M. These leases have various expiry dates.
There are three surface dispositions in the reserve related to petroleum and natural gas. Ranger Oil Ltd. holds mineral surface lease #10342 which covers the wellsite at 7-15-42-5-W4M as well as the access trail to the southeast. Canadian Jorex Ltd. holds mineral surface lease #850750 for the wellsite in Section 3 (currently being reclaimed). Jorex also holds Licence of Occupation #850463 covering the access trail to the east of the

12-3 well.

Most of the seismic lines are growing back to shrubs and trees. Some of these lines and some of the access trails were at one time seeded to non-native grasses and legumes. Establishment of these introduced species along the lines and trails has been poor and most of the vegetation cover is composed of native species. Lines provide minimal access to vehicles and livestock. Trails presently provide important vehicle and livestock access.

One wellsite area in Section 2, which was disturbed but never drilled, has been reclaimed. The well in Section 3 is still in the process of being reclaimed. All other wells, except for 7-15, have been naturally reclaimed.

3.6.2 Recreation

Past recreation activities in and around the ecological reserve includes hunting, camping, walking/hiking, bird-watching, plant study and identification, photography, snowmobiling, horseback riding and all-terrain vehicle uses.

Some of these identified recreation uses and other recreation activities will cause damage to the biological diversity and special features of the reserve. Some damage may be irreversible. Recovery time on these xeric and mesic environments is unknown, possibly taking decades.

3.6.3 Historical Land Use

Before European settlements the parkland was heavily populated with large herbivores--bison, elk (wapiti) and to a lesser extent antelope. The nomadic population of Indians--Cree, Ojibwa or Saulteux, and Assiniboine--lived principally on bison. The large game animals and the Indians, through their hunting and fighting, generally disturbed the parkland and interfered with successional changes but kept it in a relatively stable subclimax condition.

The length of time that these conditions prevailed is unknown. MacNeish (1956) traced cultures in Manitoba from before 3000 B.C. to about A.D. 1750. The oldest culture he examined was the Whiteshell Focus, excavated in the Whiteshell Forest Reserve of southeastern Manitoba. Here, he found the Indians had been living on bison and not forest game. Wettlaufer (1956) excavated a stratified site at Mortlach, Saskatchewan, near Moose Jaw not far south of the present boundary of the parkland. He found cultures dating back approximately 3400 years. The food of the Indians in this area was also bison.

Influence of Fire

Indians set many fires. Both Henry and Hind frequently referred to them. The following quotations from Hind (1859) are particularly revealing:

Putting out [setting] fire in the prairies is a telegraphic mode of communication frequently resorted to by Indians. Its consequences are seen in the destruction of the forest which once covered an immense area south of the Qu'Appelle and Assiniboine. The aridity of those vast prairies is partly due to this cause. The soil, though light, derives much of its apparent sterility from the annual fires.

In low places and in shallow depressions where marshes are formed in spring, the soil is rich, much mixed with vegetable matter, and supports a very luxuriant growth of grass. If willows and aspens were permitted to grow over the prairies, they would soon be converted into humid tracts in which vegetable matter would accumulate, and a soil adapted to forest trees be formed. If a portion of the prairie escapes fire for two to three years the result is seen in the growth of willows and aspens, first in patches, then in large areas, which in a short time become united and cover the country; thus retarding evaporation and permitting the accumulation of vegetable matter in the soil. A fire comes, destroys the young forest growth and establishes a prairie once more. The reclamation of immense areas is not beyond human power. The extension of the prairie is evidently due to fires, and the fires are caused by Indians, chiefly for the purpose of telegraphic communication, or to divert the buffalo from the course they may be taking. These operations will cease as the Indians and buffalo diminish, events which are taking place rapidly.

From beyond the South branch of the Saskatchewan to Red River all the prairies were burned last autumn, a vast conflagration extending for one thousand miles in length and several hundreds in breadth. The dry season had so withered the grass that whole country of Saskatchewan was in flames. The Rev. Henry Budd, a native missionary at the Nepoween on the North Branch of the Saskatchewan, told me that in whatever direction he turned in September last the country seemed in a blaze; we traced the fire from the 49th parallel to the 53rd, and from the 98th to the 107th degree of longitude. It extended no doubt to the Rocky Mountains...The prairie on the west of the Souris as well as on the east is treeless, the banks of the Snake Creek [Plum Creek] support a thin belt of small forest trees, such as oak and ash, with a few ash-leaved maple. The annual fires prevent the willows and aspens from covering the country, which they undoubtedly would do until replaced by other species, if not destroyed to within a few inches of the root every time the fire sweeps over them.

...He had not visited it [Pipestone Creek] for twenty years, and the timber, consisting of aspens and willows which then covered the country, had nearly all disappeared. The old man was correct, the face of the country had changed. The aspen forest had been burnt and no vestige remained.

...Ponds and lakes are numerous on the Grand Coteau side, and it is probably on this account that the Buffalo cross the Qu'Appelle valley near the Moose Jaws Fork and west of Buffalo Pound Hill Lake; in the winter they keep towards the Touchwood Hills for the sake of shelter; and the excellent herbage which grows in the beautiful meadows between aspen clumps. The prairies there too are not so often burned as south of the Qu'Appelle, the valley of that river serving as a great barrier to prevent the onward progress of the devastating fires.

In addition to destroying the forest and increasing the area of grassland, fires destroyed the nests and nesting sites of ground-nesting birds and voles and created arid, short grass conditions favourable for the Richardson's ground squirrel.

Fires were set so frequently that they maintained a prairie subclimax which would, if left undisturbed, be invaded by aspen. The use of fire by primitive peoples to change the vegetation is universal. This practice was described by Stewart (1956), who summed it up in the following statement.

The unrestricted burning of vegetation appears to be a universal culture trait among historic primitive peoples and therefore was probably employed by our remote ancestors. Archeology indicates that extensive areas of the Old and New Worlds were being burned over ten thousand years ago. It is logical to assume that some of the reasons which motivated historic and Neolithic men would also have motivated our remote ancestors to set vegetation on fire. One may conclude that fire has been used by man to influence his geographic environment during his entire career as a human. Furthermore, it is impossible to understand clearly the distribution and history of vegetation of the earth's land surfaces without careful consideration of fire as a universal factor influencing the plant geography of the world.

Excerpt from Buffalo Trails and Tales - Wainwright and District.

In the fall of 1911, the weather had been warm and dry for weeks. The grass had not been touched by fire or stock since the time of

the buffalo. The prairie was covered with grass about two feet deep. It was almost impossible to walk across the land unless you followed a wagon track. The poplar and willow bluffs, and there were lots of them in this district, were a tangle of undergrowth, peavine and the like. You might say the setting was ripe for a fire. The settlers were few and far between, with only patches of breaking here and there.

...For weeks after the fire had gone by, the prairie sod burned in great patches, right down to the clay. It kept burning until the snow came. The poplar bluffs with trees a foot through, kept burning. At night, with everything so black, the whole country was dotted with lights. It looked like candles with every once in a while, a tree exploding into flame.

This fire burned the entire district from Wainwright east into Saskatchewan, and from the C.N. Railway north of Vermilion and Lloydminster.

3.6.4 Surrounding Land Use

The surrounding area is rich and diverse in land use history.

Buffalo National Park (North Boundary of Ecological Reserve)

In 1907-1912, the Canadian Government purchased from Michel Pablo a total of 716 bison. These animals were offspring of the historic "Walking Coyote" herd, "the last of the prairie buffalo." In 1907, the Minister of the Interior made arrangements to secure about 44 km^2 (160 sq. mi.) of public prairie land just north of the Wainwright Dunes to protect these grazing animals. In 1913, this area became officially known as Buffalo National Park. The population of bison in 1913 totalled approximately 1188 head.

From 1913 to 1940, the park was very active including the daily activities of managing the bison, roundups, slaughter process, hides, animal management, transportation to Wood Buffalo National Park, experimental crossbreeding programs, e.g., King, the famous buffalo-shorthorn cross that weighed 1089 kg (2400 lb.).

Department of National Defence, Wainwright

Buffalo Park closed in 1940 and was turned over to the Department of National Defence to provide an area for military training purposes. "Cattalo" experiments, i.e., the breeding of bison and cattle, continued until the 1950s.

The Department of National Defence now manages a herd of approximately 20 bison.

Falcon Breeding Farm

In 1970, the Canadian Wildlife Service, established a falcon breeding facility Betty Lake.

Buffalo Park Grazing Association History

During the early 1900s, the Wainwright Dunes area was open range grazed freely by horses and cattle. In 1948, the Wainwright Dunes area was leased to the Buffalo Park Grazing Association as part of their overall livestock grazing operations. This area is part of a grazing management area called BP 4.

South Neighbours - Ranching History

Lands located south of the ecological reserve are a mix of private and public lands. Land use within the townships south of the reserve is grazing, with about three-quarters of the area being grazed native range that shows many similarities to the reserve. The remaining one-quarter of the area consists of lands used for tame forage production, both hayed and pastured. There is a very limited amount of cultivation for cereal crops or oilseed crops.

Ranching in the area south of the reserve has been ongoing since the early 1900s. During the years of 1900-1950, pieces of the area were broken, cultivated and cropped. Because much of the land is unsuitable for annual cropping, these bits and pieces of land have been seeded to grass or allowed to revert to grassland. Current neighbors are Russel, Darrell and Jeffrey Grocock; Worden Walters; the Hutterite Brethern of Ribstone; and Lorne and Diane Maull.

4.0 MANAGEMENT ISSUES

The following are management issues, identified by the Terms of Reference and the Management Planning Team, that must be addressed in order to accomplish the primary purpose of the Wainwright Dunes Ecological Reserve.

- Role of shrub and aspen encroachment onto grassland ecosystems.
- Degree to which neighbouring land uses impact the Reserve's landscapes and ecosystems.
- Role of livestock grazing.
- Role of hunting.
- Protection of significant features, i.e., slope fen.
- Petroleum and natural gas extraction.
- Role of horse use.
- Protection of rare plant species.
- Protection of rare animal species.
- Reclamation of disturbances.
- Recreation use.
- Trapping.
- Motorized vehicle access.
- Weed control.

- Fire and other disturbances resulting from Camp Wainwright exercises.
- Role of fire as a management tool.
- Management committee to implement, monitor and revise the management plan.

5.0 VALUES, GOALS, AND OBJECTIVES

5.1 Values

5.1.1 Value Statement

The Wainwright Dunes Ecological Reserve is representative of a biodiversity of aspen parkland ecosystems on sand outwash and sand dune landforms. In addition, this ecological reserve contains unique features, including the most southerly representation of boreal fen ecosystems. Accompanying the parkland and fen ecosystems is a rich diversity of flora and fauna including rare species.

5.1.2 Core Values

The following resource features are the primary reasons for the establishment of the Wainwright Dunes Ecological Reserve (Appendix 6):

-Extensive Beaver pond and Fen Complex
- unusually extensive fens for the Central Parkland and southernmost fens in eastern Alberta
- numerous beaver ponds
- diverse wildlife habitats
- numerous rare and widely disjunct plants (pale green sedge, white bog orchid, selfheal, linear-leaved sundew, Chamisso's cotton grass, oblong-leaved sundew, elephant's head, showy everlasting, flattened spike-rush)
- several uncommon birds (black-billed cuckoo, sharp-tailed sparrow, black-and-white warbler)
- represents organic type of soil for Central Parkland

-Patterned Fen
- most distinctive patterning in fen complex
- concentration of rare, uncommon and widely disjunct plants (elephant's head, prairie sedge, sticky asphodel, slender-leaved sundew, Chamisso's cotton grass, white bog-orchid, pale green sedge)

-Open Fen (SW 10 and SW 11)
- concentration of widely disjunct, rare and uncommon plants (elephant's head, sticky asphodel, tufted clubrush, common butterwort, prairie sedge, Sartwell's sedge, yellow lady's-slipper, white bog-orchid)

-Slope Fen
- rare biophysical unit
- numerous uncommon and widely disjunct plants (sticky asphodel, tufted clubrush, elephant's head, white bog-orchid, fringed gentian, water horehound, yellow lady's slipper, Kalm's lobelia)

-Extensive Marshes and Open Water
- good representation of marsh and open water in parkland
- productive waterfowl and shorebird habitat
- sandhill crane and sharp-tailed sparrow (uncommon birds)
- wigeon-grass (rare plant)

-Moist Meadows (Section 2)

- moss gentian (rare plant)
- representative of gleysols in the Central Parkland

-Rugged Dune System
- representative of dune systems in the Central Parkland
- several active blowouts
- rare plants (sand nut-grass, annual skeletonweed)
- represents regosols and weak chernozems occurring elsewhere in the Central Parkland

-Extensive Active Blowouts in SW 15
- rare and uncommon plants (sand heather, sand nut-grass)

-Active Blowout in Center of Section 16
- rare and uncommon plants (sand nut-grass, Houghton's sedge)

-Active Blowout in SE 14
- rare and uncommon plants (annual skeletonweed, sand heather)

-Active Blowout in NW 9
- sand nut-grass (rare plant)

-Dense Woodland in Section 11
- Cooper's hawk nest (rare bird)

-Dense Woodland in Section 3
- Cooper's Hawk nest (rare bird)

-Moist Meadows in SE 10
- uncommon and declining plants (meadow blazingstar, short-stemmed thistle, western wood lily)
- productive butterfly habit

-Open Fen in NE 10
- uncommon and widely disjunct plants (prairie sedge, Chamisso's cotton- grass)

-Large Fen in Mostly the Southeastern Quarter of Section 3
- diverse breeding bird habit

-Lush Aspen and Balsam Poplar in NE 4
- diverse breeding habitat
- ruby throated hummingbird (uncommon bird)
- representative of Dark Gray Chernozems in the Central Parkland

-Large Beaver Pond and Marsh in NE 3 and SE 10
- widely disjunct plants (variegated horsetail, eel-grass pondweed)

-Grassland in SE 3
- large stand of brittle prickly-pear (uncommon plant)

-Lush Open Woodland Mainly in SE 10
- dwarf milkweed (uncommon plant)
- occurrence of Dark Gray Chernozems

-Aspen Woodland in SW corner of 10
- uncommon and widely disjunct plants (long-leaved bluets, common wood- rush)
- Dark Gray Chernozems

-Extensive tall willow in section 16
- common wood-rush (uncommon plant)
- Gleysols

-Lush Sedge Marsh in NW 3
  - black-and-white warbler, black-billed cuckoo (uncommon birds)
  - spotted coralroot (uncommon plant
-Active Blowout in NW
-Mature Woods in SE 16
  - large old balsam poplar and paper birch
-Level Sandy Outwash Plain
  - good representation of an outwash plain
  - grasslands
-Rolling Sandy Outwash Plain
  - good representation of this type of outwash
  - aspen woodland and grassland
  - minor representation of tall willow shrubbery
  - minor kame moraine
-Sandy Outwash Plain
  - good representation of this type of outwash
  - undulating upland
  - extensive tall willow shrubbery and aspen and balsam poplar woodland
-Dunes in Primarily the SW Quadrant of the Reserve
  - represents similar features of the Central Parkland
-Interdunal Depressions
  - extensive aspen, balsam poplar woodland and tall willow shrubbery
-Undulating Sandy Outwash and Lake Deposit Complex
  - extensive moist meadows and sedge wetlands in low-lying areas
  - silverberry and buckbrush thickets, balsam poplar and aspen woodland

5.1.3 Support Values

The following resource features must also be protected as supportive values to the prime reasons for the establishment of the Wainwright Dunes Ecological Reserve.

- Sand dunes, interdunal depressions, and sand outwash plain landscapes house the biological diversity representative of aspen parkland ecosystems.

- David Lake, which supports the riparian environment for adapted plant and animal species within the ecological reserve.

- Beavers whose behaviour supports the functioning of the fen ecosystems and provides habitat for the adapted plant and animal species.

- Regional ground water flows support the diversity of ecosystems and species of the ecological reserve.

5.2 Goals

The primary goal of this management plan is to protect the representative and special features of the Wainwright Dunes Ecological Reserve. The functioning of healthy ecosystems in a natural state is of paramount

importance. This management plan seeks to ensure the primary goal is accomplished through a hands-off, low-impact management strategy. However, this plan also recognizes the need to artificially maintain and produce desirable impacts when natural impacts are no longer available or practical, e.g., the role of fire and herbivore grazing. An important feature to this plan is the requirement for a "management committee" that would oversee the implementation of the plan and develop specific operational guidelines to address issues stated in this plan and new issues as they arise. Another important requirement of this plan is to monitor the management strategies to ensure they are working properly.

5.3 Objectives

5.3.1 Protection

- To maintain the health, vigor and diversity of grasslands and their plant and animal species.
- To monitor and control the encroachment/invasion of non-native species and weeds.
- To maintain as a maximum the present level of aspen and shrub succession onto natural grassland openings.
- To maintain aspen, riparian and fen ecosystems in excellent ecological condition.
- To maintain a diversity of forest, shrub, and grassland plant communities.
- To monitor and maintain the presence and abundance of rare species' populations.
- To improve the health, vigor and productivity of the grasslands at David Lake.
- To maintain healthy ungulate populations and their habitats.
- To provide opportunities for compatible, non-destructive scientific research and investigation.
- To monitor the success of existing reclamation projects.
- To restore disturbed areas and maintain the succession on them toward native species.
- To control the invasion and spread of weed species as defined under the Weed Control Act.

5.3.2 Heritage Appreciation

- To permit (not promote) opportunities for interested individuals and small groups to explore, understand, and appreciate (in a compatible manner) the Wainwright Dunes Ecological Reserve through personal interaction with the environment.

5.3.3 Outdoor Recreation

- To permit (not promote) foot access, nonconsumptive, nature-oriented recreation to the extent that it does not compromise the protection objectives of the ecological reserve.

5.3.4 Ecotourism

- To provide (not promote), at locations outside the reserve information and orientation to assist visitors to understand, experience, protect,

and safely enjoy the reserve.

- To not promote the Wainwright Dunes Ecological Reserve as a tourist destination and attraction point.

- To provide interested individuals and organizations with the results of scientific research from Wainwright Dunes Ecological Reserve so that these results may assist ecotourism opportunities in similar areas outside the Wainwright Dunes Ecological Reserve.

6.0 MANAGEMENT GUIDELINES

The following guidelines are management strategies designed to protect and conserve the natural resources and features of the Wainwright Dunes Ecological Reserve. Each strategy attempts to perpetuate the proper functioning of the Wainwright Dunes Ecological Reserve ecosystem and maintain the biological diversity of species, habitats and niches. Species include all forms of life including soil micro-organisms, insects, birds, terrestrial and aquatic animals and vascular and nonvascular plants. These strategies recognize that some historical natural processes are not available and human manipulation is required, i.e., fire and grazing animals. Human interference with the natural processes is goal-oriented and is intended to occur at a minimal level only. An important requirement to manage the Wainwright Dunes Ecological Reserve is the development of an "Advisory Committee," which would develop operational guidelines, monitor expected accomplishments and resolve new issues.

6.1 Protection (Resource Management)

6.1.1 Geologic and Geomorphic Resource Management

Geologic and geomorphic resources, that is, bedrock, surficial deposits, landforms and soil are an integral part of ecological reserves. Management requirements and the need for protection vary greatly from one resource to the next, as well as between reserves. In many reserves, no active management is required. In others, geologic and geomorphic resources may be the primary reason for reserve establishment. In general, the more significant landforms or features should receive higher levels of protection. Degree of protection should be consistent with the risk to the resource.

Objectives:

1. To maintain processes that promote areas of active dune instability. Research is required to determine the role of fire, grazing and climate in maintaining areas of active dune instability.

6.1.2 Atmospheric Resource Management

The quality of fresh air is generally considered to deteriorate when the normal concentration of gases is altered or new substances, including particulate matter, are added. These changes result from human activities as well as natural processes. The leading source of air contaminants in Canada is the combustion of fossil fuels. When air standards deteriorate,

both aesthetic and environmental damage increase.

Natural resources may be impacted over the longer term. The basic direct and indirect biological effects on plants and animals include elimination of sensitive species, selective removal of larger plants and reduction in amounts of nutrients available in the soil.

The sources of manmade, airborne pollutants may be local or distant from the ecological reserve. Local sources include industrial activities, gas wells and pipeline leaks. Distant sources include dust from industrial plants, major well blowouts, etc.

Objectives:
1. To manage the effects of airborne pollutants on ecological reserve resources.
2. To monitor ambient air quality to determine baseline data.
3. To comply with air quality standards that suit the environmental and aesthetic values.
4. To monitor for hazardous levels of industrial pollutants.

6.1.3 Aquatic Resource Management

Aquatic resources include the surface water, ground water, and water-land interfaces of the Wainwright Dunes Ecological Reserve. The quantity and quality of these water resources impact the establishment, health and productivity of plants, animals and habitats. Water quality changes caused by petroleum and natural gas extraction, recreational use, and livestock grazing may affect rare fen and wetland plant species. Livestock grazing may physically disturb springs, beaver ponds, and wetland areas and over the long term contribute to enrichment and denser vegetation in David Lake. Water supply to the Reserve may be affected by large groundwater uses or by surface water diversions, in areas adjacent to the Reserve.

Objectives:

The following guidelines are based on the premise that water is an important component of the natural ecology of the Reserve and that there are scientific and management reasons for establishing baseline conditions of the water resource and tracking changes in future years. It is assumed that in practice, water resource monitoring would be combined with other kinds of biophysical monitoring. The guidelines aim for protection of the natural ecology of the Reserve by preventing disturbances and permitting only minor domestic uses of water in areas contributing surface and groundwater to the Reserve and David Lake.

Surface Water Objectives

i) To provide a better understanding of water supply conditions in the Reserve, David Lake water levels should be monitored regularly at least twice a year, after spring runoff and in fall. A benchmark should be established for this purpose.

ii) Baseline water quality monitoring should be done for David Lake, the ponds, creeks, and fens to provide information useful to understanding the survival needs of some of the rare fen and wetland species and to help track enrichment due to livestock grazing. Once baseline quality is determined, monitoring to track change should be done only at 5 year intervals but more frequently if contamination or other problems are suspected.

iii) The ponds, streams, wetlands, and springs should be monitored twice a year, spring and fall, by visual inspections. These should check for the amount of flow and clarity of the water, and for any distrubances. Observed conditions should be recorded in a log.

iv) No diversion of surface water flow within the Ecological Reserve or the contributing watersheds should be permitted.

v) The spoil piles beside the David Lake DU level ditches and the new livestock dugout should be spread and sown with natural grasses as required by permit conditions.

Groundwater Objectives

Baseline data on groundwater conditions in the Reserve and surrounding area should be obtained. Management should include the following measures:

i) A survey to identify wells and their uses and to confirm that there are no significant groundwater users.

ii) A survey of springs to identify locations, estimate flows, and determine water quality.

iii) After baseline data is determined and as long as major industrial or agricultural development within the contributing watersheds is restricted, ongoing groundwater quantity and quality monitoring is not considered necessary.

iv) The use of shallow groundwater or springs within the Ecological Reserve or the David Lake watershed should be limited to non-motorized recreational use or domestic needs. If recreation becomes an approved use on the Reserve, physical protection of the source of the springs should be considered, as well as measures to prevent groundwater contamination.

Referral Objectives

All applications for surface or groundwater permits and licences within the watersheds contributing to the Reserve and David Lake should be referred to the Manager of the Ecological Reserve for input.

6.1.4 Vegetation Resource Management

6.1.4.1 Plant Species Management

A major reason for the establishment of the ecological reserve is to protect plant species. The presence and abundance of plant species can provide a measure of how ecosystems are functioning and their state of health. In turn, this information can assist the manager in determining whether protection goals are being accomplished and make management corrections where needed.

Objectives:

1. To carry out a complete survey of non-vascular and vascular plants and their habitats in the Wainwright Dunes Ecological Reserve and maintain an updated list of these species.
2. To monitor the presence and abundance of rare species to evaluate ecosystem function and health.
3. To monitor representative species, e.g., rough fescue, as a measure of ecosystem function and health.

6.1.4.2 Fire Management (Brush and Aspen Encroachment)

Fire is considered to be a natural part of the aspen parkland ecosystem that can assist in maintaining the biological diversity of species and habitats.

Objectives:

1. Preparation of a plan that includes the following objectives: to define the range of the desired amount of aspen encroachment onto grassland plant communities; to determine the present ratio of aspen to grassland plant communities; and to monitor changes in this ratio over time.
2. Preparation of a prescribed burning plan that includes goals and objectives according to the protection needs of species, habitats and special features.
3. Preparation of a fire suppression plan to address the need to extinguish wildfires. This plan would include a discussion of prevention, detection, suppression and postfire rehabilitation.
4. Ensure that visitors are aware that campfires are prohibited. The use of portable camp stoves for cooking is permitted.
5. Ensure that the burning plan includes the involvement and agreement of the DND, adjacent local residents, MD of Provost and MD of Wainwright.

6.1.4.3 Grazing Management

Herbivore grazing of grasses, forbs and shrubs is considered a natural part of the aspen parkland ecosystem. As a result of the extirpation of bison and elk and other native herbivore species, the need for human interference to simulate these grazing effects is desirable. Although cattle are not replicates, they can have positive impacts such as maintaining grassland openings and assisting ecosystem functions of

grasslands that benefit plant and animal species, i.e., biodiversity of grazed habitat patches in heavy, moderate, light and non-use types. Alternatively, cattle can have negative impacts on the Wainwright Dunes Ecological Reserve such as loss of habitat and species. A grazing strategy that maintains positive impacts and minimizes negative impacts is required for the reserve.

Objectives:

1. The number of grazing cattle should be in balance with the available forage supply. This number may be adjusted yearly based on range condition, moisture and other management factors. The Animal Unit Month concept will be used to calculate the grazing capacity each year.

2. Cattle will be allowed to graze in late summer and during the dormant part of the growing season (July to September). This restricted grazing period will minimize injury to plants during their active growth period (May to July).

3. Range management techniques shall include minimal fencing and the use of ecological principles and practices for range management, rather than intensive fencing and the use of agronomic principles and practices of tame pasture management. For example, stocking rates will be based on ecological site and condition classes. This type of management will help to enhance the diversity of habitats, species and niches.

4. Range management shall minimize grazing in the fen systems. Salt blocks will be placed a minimum of one quarter mile from all watering points (natural and man-made).

5. The grazing contractor (presently Buffalo Park Grazing Association) is responsible for maintaining of all cattle fences including the perimeter, drift and crossfences, and removing of all associated litter such as barbed wire and twine. Temporary portable corrals can be erected for putting cattle onto the range and removing them in the fall.

6. The grazing leaseholder cannot use a motor vehicle except when putting out salt blocks, repairing fences, tending sick animals, or in other special circumstances relating to grazing management. Motor vehicles can be used only on existing access routes, and horse use is encouraged where practical.

7. A plan shall be developed to monitor cattle grazing and evaluate the impact. Grazing may then be adjusted to enhance the positive impacts while minimizing the negative effects. The plan shall include the monitoring of plant species, habitats and several range reference areas to compare plant community composition and productivity in grazed versus non-grazed conditions. One goal of the grazing management strategy is to maintain all plant communities in excellent

ecological condition.

8. The ecological condition of David Lake shall be improved from fair to good. Presently the Dunes area is rated in good to excellent ecological condition.

9. Existing range improvements (dugouts, fences, fencelines and trails) are to be maintained in good condition. No additional range improvements are permitted in the ecological reserve unless they are required for ecological management purposes.

Grazing System
For grazing management purposes, the ecological reserve will be divided and fenced into two controlled management areas called the Dunes and David Lake pastures. The amount of time spent in either pasture shall be regulated by the grazing capacity. Livestock grazing is allowed in each pasture for one grazing period each year only (no rotational grazing).

Grazing Capacity
The grazing capacity of the Wainwright Dunes Ecological Reserve is 930 Animal Unit Months (AUMs). This grazing capacity is based on the Dunes area of the Buffalo Park Grazing Association lease (6160 ac.), which produces an annual forage production of 300 lb./ac. and retains 150 lb./ac. of production as carryover to maintain productivity. The Dunes area provides a grazing capacity of 600 AUMs. The David Lake area of the Buffalo Park Grazing Association lease (887 ac.) produces an annual forage production of 750 lb./ac. and retains 375 lb./ac. of production as carryover to main productivity. The David Lake area provides a grazing capacity of 330 AUMs. Carryover of vegetation in the Dunes and David Lake areas is required for nutrient cycling, wind buffer, erosion prevention, site moisture, wildlife habitat, and other ecosystem needs.

Grazing Season
The grazing season in the ecological reserve is July 10 to September 30. Livestock will not be allowed to enter the Reserve before July 10th each year, and they are removed by September 30th each year.

Significant Features Protection
The large fen complex located north and west of David Lake shall be fenced in a manner that minimizes livestock use. Presently this entails use of a drift fence on the southeast side of the fen.

6.1.4.4Weed Management
The potential for invasion of restricted, noxious and nuisance weeds exists in the Wainwright Dunes Ecological Reserve. Weeds can enter the Reserve through natural and human means, eg., birds, water, wind, livestock and vehicles. Currently, the primary concern is toadflax entering the Reserve.

Objectives:
1. Management of the Ecological Reserve will recognize the need to manage

weeds consistent with the direction provided in the Weed Control Act.

2. A commonsense approach should be taken to controlling weeds, selecting the method that has the least negative impact on the purpose of the ecological reserve. Methods for controlling weeds include hand picking, mechanical, biological, and chemical.

3. No native or tame hay is permitted to be brought into the ecological reserve.

4. No use of introduced species are permitted in the ecological reserve.

5. Any use of herbicides must be target specific (selective) and applied in accordance with the regulations, acts and regulatory authorities.

6. The management committee shall prepare a list of potential weed species for the Wainwright Dunes Ecological Reserve.

6.1.4.5 Introduction of Exotic and Non-ecotypic Species Management

Where reclamation is required, only ecotypic native species must be used. Where these are not available, reclamation will be allowed to occur naturally. No matter which reclamation methods is used, a weed control program may be required.

Objectives:

1. The use of introduced, exotic or non-ecotypic native species is not allowed in the Wainwright Dunes Ecological Reserve for reclamation purposes.

6.1.4.6 Significant Features Management

A major feature of the Wainwright Dunes Ecological Reserve is the presence of rare and unusual species, particularly in the large fen and active dune areas. The species/habitats listed in the following objectives require specific monitoring to ensure their perpetuation.

Objectives:

1. A low level of use by livestock in the active blowouts in the southwest corner will continue. These blowout areas contain one of only two populations of sand nut-grass (*Cyperus Schweinitzii*) found in Alberta. The other population is found at Pakowki Lake in southeastern Alberta. In Pakowki Lake, this species is not in an area that is being grazed heavily.
2. To protect the moist meadows west of David Lake where moss gentian (***Gentiana fremontii***) grows.

3. To protect the central part of the large fen which supports a population of slender-leaved sundews (*Drosera linearis*).

4. To protect the slope fen north of David Lake that supports a number of uncommon and disjunct species.

5. To develop a plan that priorizes which of the many uncommon and disjunct species that will be monitored.

6.1.5 Animal Resource Management

6.1.5.1 Habitat and Species Management

Hunting is considered a management tool for maintaining and protecting the integrity of lands and resources within and bordering the ecological reserve. Presently, the hunting of white-tailed deer may be necessary to prevent habitat damage and the potential overpopulation of animals which can lead to disease, hybridization with mule deer. A recommendation for a deer hunting season within the ecological reserve will require formal justification as a resource management requirement.

Presently, hunting other wildlife species (i.e., waterfowl and upland birds) is not a requirement for meeting the stated purpose of the ecological reserve.

Objectives:

1. Access for hunting is by foot only.

2. Management and harvesting ungulates will be based on the best possible animal census data from the ecological reserve and neighbouring lands. It is recommended that any plan for hunting in the ecological reserve be coordinated with the Camp Wainwright Military Reserve census, harvesting and monitoring plan.

3. It is recommended that a self-registered harvest is used to calculate the actual number of animals harvested.

4. Commercial and recreational trapping is prohibited by the Act.

5. To improve the enforcement capability, it is recommended that the S 1/2 of Section 2 and NW Section 35 covered by the waters of David Lake are included in the ecological reserve by Order In Council.

6.1.5.2 Significant Features

The following animal species require monitoring to determine their presence and abundance.

Objectives:

1. Undertake a breeding bird survey to monitor species and the variety of habitats used.

2. To monitor the Cooper's hawk and the sandhill crane.

3. To provide data on which to base habitat and species management (see subsection 6.1.5.1) through the census and monitoring of members of the deer family which includes moose, elk and mule deer. This work will also occur for antelope.

6.1.5.3 Problem Wildlife Management

Although wildlife is a basic part of nature, some species may be considered problem wildlife because of their damage to parts of the environment and to humans. Specifically this includes damage to property outside the ecological reserve and harm to special features and rate species.

Objectives:

1. The management committee will discuss problem wildlife species and decide on what action, if any, can be taken.

2. Removal of any animal species, such as through hunting or trapping, would be regulated by legislation including the W.A.E.R.N.A. Act and the Wildlife Act.

3. The management committee will identify conditions and parameters within which wildlife species would pose a threat to rare and special species and habitats in the ecological reserve.

6.1.5.4 Invertebrate Pest and Disease Management

Pests and diseases of species in the ecological reserve may need to be controlled when they threaten significant values, such as habitat for rare and endangered species.

Objectives:

1. The management committee will discuss problem pest(s) and/or types of disease and decide on the action, if any, that should be taken. Biological control methods should be used whenever possible.

2. Chemical pesticides should be used only when absolutely necessary and when there is no other alternative. If a pesticide is used, it should be target specific.

6.1.5.5 Species Re-Introduction

A natural (hands-off) approach is recommended for population changes in wildlife species, and species re-introduction is not permitted except for management purposes. For example, the loss of beaver may create a negative impact to the habitat and species that require a beaver pond-fen environment. In this example, beaver may be introduced into the Ecological Reserve for management purposes.

Objectives:

1. The management committee would review any issues surrounding species re-introduction issues and decide what action, if any, will be taken.

6.1.6 Historic Resource Management

6.1.6.1 Archaeological Resources

Previous research in this region of the province indicates that the area was heavily used during prehistoric times. The cultural history of the area began about 11 000 years ago and extends consistently through the early, transitional, middle and late prehistoric periods. While no sites

have been identified in the planning area to date, there is high potential for site discovery. Sites are likely to be found in areas associated with sheltered, well-drained, south-facing aspects or close to both present and historical water sources.

6.1.6.2 Historic Structures

Currently there are no recorded historical structures in the Historic Site Service Inventory for the Ecological Reserve. Should such buildings be discovered, the Historic Sites Service would appreciate being notified.

6.1.6.3 Paleontological Resources

There are no known significant historical resources in the planning area, but this may be because the area has not been surveyed. Staff of the Provincial Museum would appreciate being notified should any fossil mammalian remains be encountered.

The ecological reserve is situated in an area identified unknown on the Tyrell Museum of Palaeontology's Palaeontological Resource Sensitivity Zones map as having unknown potential.

Objectives:

1. To identify and protect significant historical resource sites from impact related to future development.

2. To manage historical resource sites for scientific, educational and interpretive purposes.

Guidelines of Archaeological and Palaeontological Resources

1. The Archaeological Survey of Alberta, Resource Management Section, will participate in the land use referral process to review any proposed developments within the Wainwright Dunes Ecological Reserve.

6.1.6.4 Local Historical Resources

The local history of the Wainwright Dunes Ecological Reserve is potentially rich with stories of the early settlers and their relationships with the Indians. There is also considerable information on the activities of the people and their effect on the land and its biological resources. Obtaining this historical information from the pioneers who still live in this area is considered essential for better understanding of the reserve and managing its future.

Objective:

1. The management committee will pursue further collection of this historical information by identifying families who lived in the area and interviewing them to gain a broader record of local historical information at and near the Wainwright Ecological Reserve.

6.1.7 Visual Resource Management

Visual and aesthetic resources are important values to protect because they are vital to the purpose of the Wainwright Dunes Ecological Reserve.

Objectives:

1. Aesthetic aspects of landscape management will be considered in all reclamation projects.

2. Placement and colour of fences and signs will be as unobtrusive as practical.

3. Existing fenceline clearings will be kept to a minimum width, as is practical. Fenceline clearings shall not exceed a maximum width of 50 ft (15.24 m).

6.1.8 Oil and Gas Management

All activities associated with commercial resource exploration and extraction have significant impacts on the natural features, and they are incompatible with the overall management intent of the Wainwright Dunes Ecological Reserve. With the exception of capped well in LS 7 of Section 15, all petroleum and natural gas activities inside the ecological reserve will be discontinued as stated in the WAERNA Act. Any future exploration, drilling, etc., for oil or natural gas must be accomplished from outside the ecological reserve, i.e., directional drilling. Presently, the status of existing wells are:

Objectives:

1. Fences will be removed from around wells that have received a reclamation certificate.

2. The management committee will develop a contingency plan to deal with accidental spills or releases that may affect ecological resources inside the ecological reserve.

3. Using the existing trail under MSL 10342, Ranger Oil Ltd. may extract natural gas from the capped well in 07-15-42-05-W4M. The construction of a pipeline must follow the existing MSL trail and use methods that result in minimum disturbance such as "ploughing in line." Reclamation of MSL 10342 must, at a minimum, follow guidelines set out in subsections 6.1.4.4. Weed Management and 6.1.4.5 Species Re-Introduced Management. Any methods used to remove gas from this capped well must use technology that does not require new dispositions as laid out in Sections 7 and 8 of the WAERNA Act.

LOCATION	STATUS	RECLAMATION
11-31-41-5-W4M	Drilled and abandoned Sept./58	?
11-35-41-5-W4M	Drilled and abandoned July/53	?
09-15-42-5-W4M	Drilled, plugged and abandoned	?

14-02-42-5-W4M	Location, March/85, no drilling	Certified
07-15-42-5-W4M	Drilled Oct./74, capped well	Ongoing
12-03-42-5-W4M	Drilled March/85, abandoned Dec/86	Ongoing
06-09-42-5-W4M	Drilled and abandoned, May/72	?
15-14-42-5-W4M	Drilled and abandoned, May/72	?

6.2 Heritage Appreciation

Heritage appreciation considers the importance of using the Wainwright Dunes Ecological Reserve for environmental education, interpretation, information and orientation purposes.

Objectives:

1. Environmental education projects (foot access only) will be reviewed by the management committee to determine their compatibility with the protection intent of the ecological reserve. An example of a possible compatibility would be a non-destructive university research project that enhances the understanding of ecological processes at the reserve.

2. An information package will be developed describing the purpose of the reserve and state guidelines for its use.

6.3 Outdoor Recreation

6.3.1. Access Management

Foot access is considered an acceptable, low impact use in the Wainwright Dunes Ecological Reserve. Alternatively, motorized vehicles are considered a high impact use, and can have serious negative consequences including loss of species and habitats.

Objectives:

1. No motorized vehicles are allowed in the ecological reserve except for management purposes, i.e., grazing management, weed control, emergency service and enforcement.

2. For one half day in the spring and fall, Rutledge Ranches Ltd. have permission to move their livestock through the north east corner of the ecological reserve. This is a traditional and necessary access. The activity will be monitored to ensure it has no negative impact on the natural resources of the ecological reserve.

3. Foot access is encouraged whenever practical.

4. Signage to inform the public of access guidelines and restrictions will be displayed at all access points into the ecological reserve.

6.3.2. Enforcement

Designated officer(s) to ensure motorized vehicles are not used in the reserve unless approved for management purposes.

Objectives:

1. Enforcement of the Wildlife Act and to ensure foot access in the ecological reserve is recommended.

6.4 Tourism

Tourism is not an objective of the Wainwright Dunes Ecological Reserve. It is considered a high impact use and is contrary to the protection values in the reserve.

Objectives:

1. Tourism should be directed to other outdoor recreation and preservation areas in Alberta, i.e., provincial parks and recreation areas.

2. Tourism should not be promoted in the Wainwright Dunes Ecological Reserve.

3. Ecotourism (foot access only) for environmental education purposes will be reviewed by the management committee to determine compatibility with the purpose of the ecological reserve.

7.0 SURROUNDING LAND

7.1 Buffer Zones

The following lands and waters are areas that border the Wainwright Dunes Ecological Reserve. Land uses on these areas could negatively affect the special features, plants and animals, and the healthy functioning of ecosystems in the ecological reserve. Management guidelines for future uses of these lands are recommended.

David Lake - Portions of this lake not included in the ecological reserve should be designated as a wildlife sanctuary. Such a designation would permit easier enforcement of the Wildlife Act and regulations.

DND - Propose no use of any pesticide on DND's perimeter fireguard that borders the north end of the Ecological Reserve. This restriction would reduce the risk of pesticide drift or soil leaching into the ecological reserve.

- Propose the management committee and DND develop a fire escape control plan. This plan would outline communication lines and compatible steps to control on escaped fire in the ecological reserve.

BPGA - Recommend that Land Administration Division place a reservation on surrounding lands to permit grazing as the only agricultural use allowed. This would reduce the amount of agricultural drift into the ecological reserve including weeds, fertilizer, pesticides and exotic species caused from annual cropping. Buffalo Park Grazing Association is not to use any pesticides on the fencelines bordering the Ecological Reserve.

Private Landowners (L. Maull, Hutterites, W. Walters, M.D. of Provost, J. Grocock): Send letters of understanding to private landowners bordering

the ecological reserve. Inform them of the ecological reserve and request that they do not use pesticides on any fencelines bordering the reserve.

7.2 Boundary Adjustments

David Lake is considered an integral part of the ecological reserve's ecosystem. For example, many species in the reserve depend on the water and nutrients and climate from David Lake which support riparian plant communities. In turn, these communities support wildlife which depend on them for food, habitat and cover. Presently the management plan does not include management guidelines for David Lake. Any negative impacts on David Lake can have serious consequences to the protection of the Wainwright Dunes Ecological Reserve. For this reason, it is recommended that David Lake be included within the legal boundary of the reserve, and management guidelines be developed to protect the ecology of the lake.

A small portion (± 100 ac.) of native rough fescue is presently "fenced out" of the ecological reserve. This area is presently being grazed under the direction of the Buffalo Park Grazing Association as part of their Management Unit 5 (GRL 38839). This area is rated in good ecological condition. The fence was constructed in its present location to reduce construction and maintenance costs. Moving the fence would cause additional disturbance.

It is proposed the fenceline remains in its present location, providing the ± 100 ac. remains in good ecological condition and is grazed in a manner similar to the management guidelines outlined in this plan. For example, light stocking rates and grazed during late summer and/or fall.

To further inform the public that they are approaching the ecological reserve, it is recommended that advanced warning signs be placed in appropriate areas, and ecological reserve boundary fence posts be color-coded.

8.0 RESEARCH AND COLLECTION

Collection guidelines are to be prepared by the management committee. At a minimum, all research and collection must follow the guidelines and restrictions set out in this management plan. Non-destructive research that benefits the management of the ecological reserve should be encouraged. Destructive sampling and research should be minimized and avoided wherever possible. The collection, destruction or removal of any plant or animal life, or the excavation or removal of fossils or other objects of geological, ethnological or historical interest is not allowed unless authorized. In addition, for those species defined in the life Act, a permit is required from Natural Resources Service.

Permitted research and collection must be centrally housed and made readily available and accessible to the management committee and public upon request.

Study Information Presently Being Collected

(1) A vegetation change and disturbance assessment study was completed in 1992/93 to provide direction for the management of the reserve, particularly the need and role of fire in maintaining grasslands.

(2) A benchmark methodology has been developed to measure and compare plant species frequency, cover, and productivity in grazed versus non-grazed similar sites.

Present study needs are:

(1) Development of methods to keep some active sand dunes open.
(2) Monitoring the rate of change in the density of tree and shrub species in grassland ecosystems.
(3) Monitoring of benchmarks that have been established to compare plant species frequency, cover, and productivity in grazed versus non-grazed sites.
(4) Ecosystem study of the large fen.
(5) Collecting ecological history from the landowners in the area.

9.0 IMPLEMENTATION

The Wainwright Dunes Ecological Reserve is the responsibility of the Minister of Environmental Protection. The management and administration of the reserve will be the responsibility of Natural Resources Service and Public Lands Branch. Management advice will be provided by the department's Ecological Reserves and Advisory Committees, and by the Wainwright Dunes Management Committee.

The core membership of the Wainwright Dunes Management Committee (WDMC) will consist of:
- Coordinator, appointed by the Natural Resources Service Director;
- Representatives of the Public Lands Branch, preferably the land resource agrologist whose area of responsibility includes the ecological reserve;
- Representative of Fish and Wildlife, Natural Resources Service;
- Representative of Parks, Natural Resources Service;
- Representative of the Canadian Parks and Wilderness Society;
- Representative of the Wainwright Wildlife Conservation Society;
- Representative of the Alberta Wilderness Association;
- Representative of the Federation of Alberta Naturalists;
- Representative of the Buffalo Park Grazing Association;
- Representative of the Alberta Fish and Game Association; and
- The local MLA (ex officio).

Consulting members will be brought onto the WDMC from time to time to provide and discuss specific issues, interests and areas of expertise, i.e., DND, MD of Provost, and a professional ecologist.

Priority tasks on which the WDMC should focus include:

- enforcement of the WAERNA Act and management plan in the reserve;
- establishing a management committee and defining its responsibilities and authorities;
- develop an information signage program of all access points into the reserve;
- develop an information brochure about the reserve, i.e. purpose, goals, management guidelines, do's and don'ts;
- develop a management plan that deals with wildfire, fire suppression and prescription burning;
- develop methods to maintain active sand dunes;
- ecosystem study of the large fen;
- the collection of ecological history from the landowners living in the area; and
- developing a monitoring plan, methodology and sampling techniques to ensure the reserve is maintained in excellent ecological condition and biological diversity.

The WDMC may utilize a Society to conduct fund raising activities to supplement the manpower and budget requirements to carry out management activities.The use of volunteers will be investigated to determine their values, roles and responsibilities in managing the ecological reserve.

Patrol and enforcement of the people use and legislation in the Wainwright Dunes Ecological Reserve shall be a shared responsibility between the department and WDMC. Repair and maintenance of the perimeter fence is the responsibility of the Buffalo Park Grazing Association. Funding of range improvements to accomplish ecological reserve objectives is a shared responsibility between the department and WDMC. The Buffalo Park Grazing Association is responsible for carrying out the recommended range improvements, such as crossfences and water development.

10.0 PLAN REVIEW AND AMENDMENT

This management plan will be reviewed annually by the management committee until they decide otherwise. The Public Lands Branch and Natural Resources Service will be responsible for organizing that review. This will include preparation of an annual report on all aspects relating to the management guidelines, grazing plan and long term monitoring. The report will include comments and recommendations received from the Wainwright Dunes Management Committee and the Ecological Reserves Coordinating and Advisory Committees.

Should changes to the management plan be necessary, they will be endorsed by the Wainwright Dunes Management Committee. Amendments to the plan will be noted on a covering sheet at the beginning of the plan. Natural Resources Service and Public Lands Branch will coordinate all plan amendments, in consultation with public users and agencies interested in the ecological reserve. The need for plan amendments can come from the management committee, individual sponsor groups, or departmental staff of Alberta Environmental Protection and other government agencies.

REFERENCES

- Terms of Reference for Wainwright Dunes Ecological Reserve Management Plan. September 1988. Ecological Reserves Coordinating Committee. Alberta Recreation and Parks

- The Proposed Wainwright Ecological Reserve, A Biophysical Overview. August 1986. Cottonwood Consultants Ltd. for Alberta Recreation and Parks.

- Ecological Reserves Management Planning Manual. September 1991 (Draft). Alberta Recreation and Parks.

- Wilderness Areas, Ecological Reserves and Natural Areas Act.

- Development and Approval Process for Ecological Reserve Management Plans. February 1992. Alberta Recreation and Parks.

- Goals of the Wainwright Dunes Ecological Reserve Planning Team Members. October 1991.

APPENDIX 1

PRECIPITATION AND FROST INFORMATION FOR AREA AROUND WAINWRIGHT DUNES ECOLOGICAL RESERVE

Precipitation and Frost information for area around Wainwright Dunes Ecological Reserve

Precipitation Local to Wainwright Dunes Ecological Reserve

		Precipitation Average			Precipitation Extreme					
					Low			High		
Site	Years	# Complete Years	mm	in.	mm	in.	Year	mm	in.	Year
Brownfield	1959-89	31	432.6	17	302.8	11.9	1967	582	22.9	1973
Hughenden 1.	1951-71	20	410.7	16.2	291.7	11.5	1958	488.9	19.2	1953
*Hughenden 2	1972-85	7	436	17.1	+323.8	12.7	1979	557.4	21.9	1973
*Metiskow	1951-78	17	421.5	16.6	+299.1	11.8	1965	509.1	20.0	1975
*Wainwright	1973-90	7	422.4	16.6	+297.9	11.7	1981	465.5	18.3	1975
Amisk	1968-74	7	441.5	17.4	363.2	14.3	1974	601.0	23.6	1973
*Horseshoe Lake	1969-82	2	378.5	14.9	Not enough information					
*Chauvin	1980-90	1	364	14.3	Not enough information					

* - For those stations there are months with missed information. To arrive at an average, calculations were based on monthly averages by number of observations and then the 12 months were totalled.

+ - Again, there are years present with missed data so yearly totals could not always be made. Range thus reflects only observed complete years.

Frost-Free Period

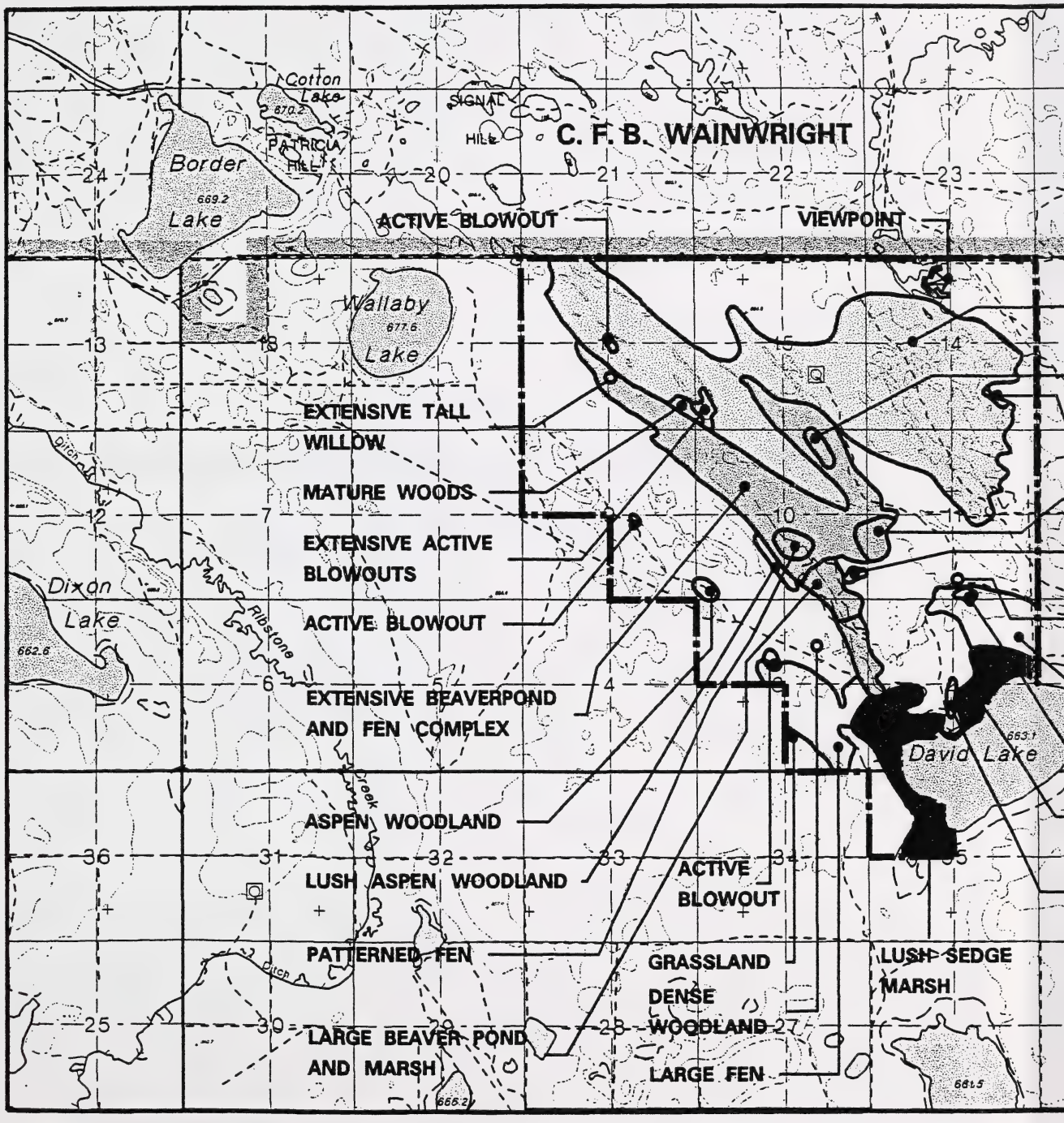
Site	# Years of Information	Frost-Free Period Average		Extreme Frost-Free Period	
		# Days	Usual Time Period	# Days Shortest	# Days Longest
Brownfield	22	92	June 4 - Sept 5	43	138
Hughenden 1	21	97	June 4 - Sept 10	24	130
Hughenden 2	9	97	May 25 - Aug 31	71	119
Wainwright-Heath	6	99	May 22 - Aug 29	76	137
Horseshoe Lake	8	118	May 16 - Sept 12	93	150

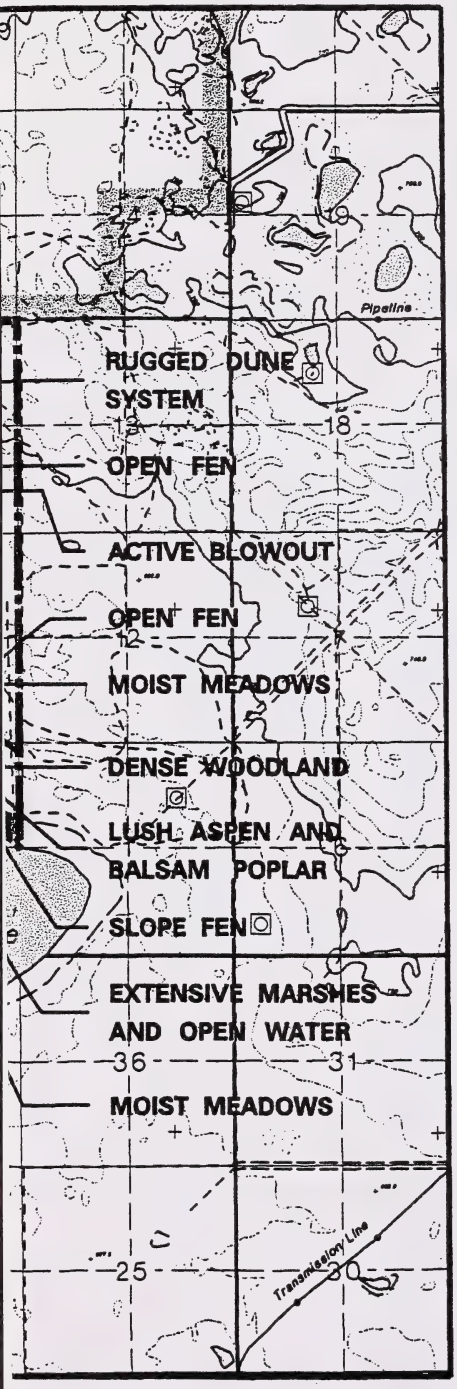
* Precipitation information received from unpublished data, Atmospheric Environment Service, Environment Canada.

* Frost information: Canadian Climate Normals, Volume 6, Frost, 1951-1980
publication of the Canadian Climate Program 1982
Atmospheric Environment Service, Environment Canada

APPENDIX 2

MAP OF SIGNIFICANT FEATURES


C. F. B. WAINWRIGHT
Cotton Lake
870.2
PATRICIA HILL
SIGNAL HILL
Border Lake
669.2
Wallaby Lake
677.6
Dixon Lake
662.6
Ribstone Creek
Ditch
David Lake
663.1
ACTIVE BLOWOUT
VIEWPOINT
EXTENSIVE TALL WILLOW
MATURE WOODS
EXTENSIVE ACTIVE BLOWOUTS
ACTIVE BLOWOUT
EXTENSIVE BEAVERPOND AND FEN COMPLEX
ASPEN WOODLAND
LUSH ASPEN WOODLAND
PATTERNED FEN
LARGE BEAVER POND AND MARSH
ACTIVE BLOWOUT
GRASSLAND
DENSE WOODLAND
LARGE FEN
LUSH SEDGE MARSH
666.2
661.5



WAINWRIGHT

CANDIDATE ECOLOGICAL RESERVE

Tp. 41 and 42 – R. 5 W4

SIGNIFICANT FEATURES

SCALE 1:50 000

Legend

STUDY AREA BOUNDARY

APPENDIX 3

RANGE CONSERVATION AS BASED ON SITES AND CONDITION CLASSES

E.J. DYKSTERHUIS

APPENDIX 3

RANGE CONSERVATION AS BASED ON SITES AND CONDITION CLASSES

E.J. DYKSTERHUIS

Source: Journal of Soil and Water Conservation
vol. 13, 1958

Range Conservation as Based on Sites and Condition Classes

E. J. DYKSTERHUIS

ACCOMPLISHMENTS IN RANGE CONSERVATION must, in the last analysis, be judged by the condition of the range—"by having a look at the grass." In the culture of our times, range practices that bring machines and chemicals into play are psychologically acceptable and widely applied. But whether they are needed and used or not, there is no lessening of the need to manage grazing for the attainment of specific conditions in the vegetation.

Management of grazing based on range condition is old in rule-of-thumb application; new in measured application. In the evolution of the range profession, what was once almost wholly an art has become at least in part a science. The shift has left us attempting to apply many old terms in a new and more scientific setting. Science is concerned with facts of how things happen and *how much*, whether the field of inquiry is chemistry or grazing management. When we attempt to measure *how much* a range is overgrazed rather than simply give it as opinion that the range is overgrazed, then we are forced to re-examine not only that term and concept, but also those often used interchangeably with it, such as poor range condition, overutilized, and overstocked. We may even have to define the terms range land and range; something we have "dodged" for a long time.

As used here, the term *range land* means land on which the climax vegetation is a natural pasture. Examples are prairie, pampa, steppe, or velt lands. Also, some savannah, desert scrub, and coastal marsh lands are range land. Much range land can profitably be cultivated, and is; but native forage plants are its natural potential. Contrasted with all natural ranges are all tame pastures. Tame pastures are composed of introduced and domesticated forage plants, singly or in mixtures. They have been established, since settlement, on range land, forest land, and other land, but they do not occur naturally. Maintenance of tame or "improved" pastures through decades generally is feasible only on arable land.

Range condition classification must logically be limited to range on range land. If volunteer pasture on forest land is classified as range in poor condition it is quite natural to assume that as cover conditions improve the grazing will improve; whereas, in reality, improvements in cover and in ecologic conditions on natural forest land will result in poorer grazing but better and better forest. The distinction between range land and other land is necessary, too, because a self-perpetuating seeding can be established only on range land. Fundamentally, it must be recognized that the natural law of plant succession operates to restore the climax or original vegetation; hence, to improve the condition of ranges on range lands but to destroy tame pastures.

Different kinds of range land are referred to as range sites. These are complexes of soil and climatic conditions. Functional differences between range sites are best distinguished by measurable differences in kind or amount of their climax vegetation.

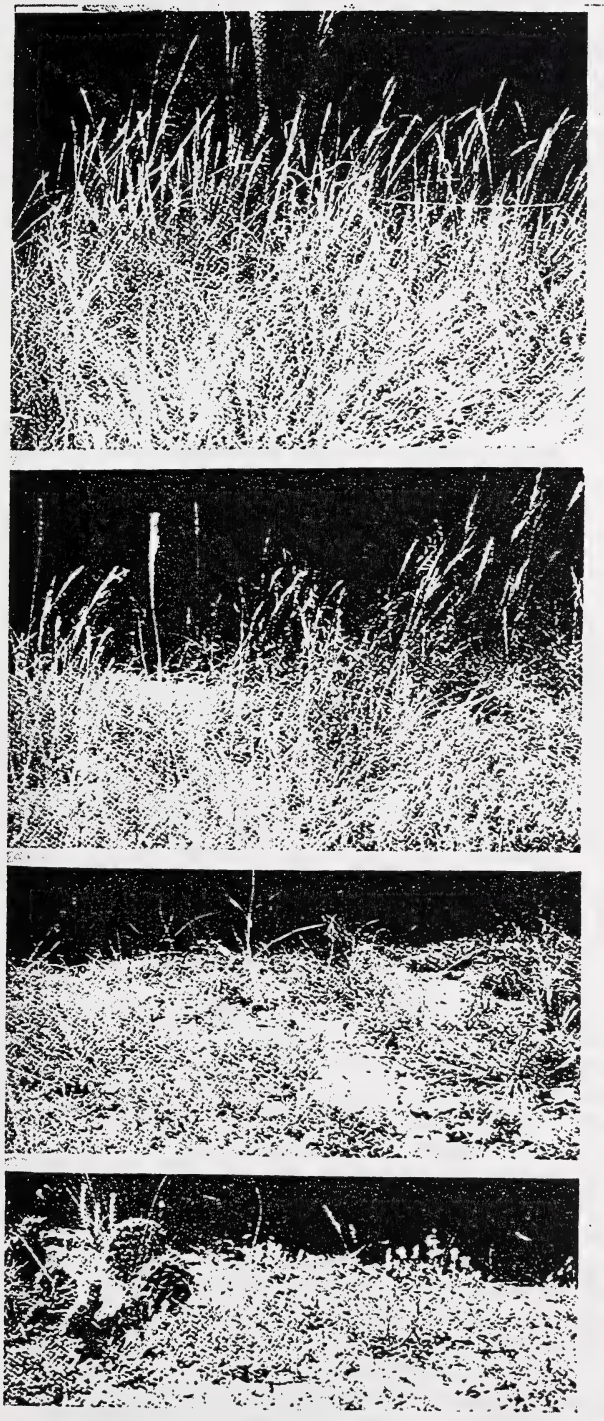
Site is not to be confused with type, because many types of vegetation may successively occupy the same range site in response to different grazing treatments. Current range condition can be measured in relation to some known potential condition and the only certain indicator of potential is the site.

Management of grazing influences range condition directly, and the site indirectly. Grazing practice determines place, time, and amount of removal of foliage. Removal of green foliage by grazing retards the growth most among the species grazed most. This favors the species grazed least because more of the water, nutrients, and light available per unit of surface is left for them. Thus, without practical management of grazing, the normally shorter species are favored as well as the least palatable and the annual species. As the taller species lose ground under close grazing, their place is taken by species short enough to escape with a high percentage of their foliage ungrazed. The result is general reduction in yield as well as measurable change in species composition.

On range lands, this process, fortunately, can be reversed. Ordinarily a change in management of grazing is all that is required. If secondary plant succession is permitted or fostered, the combination of plants that produces the greatest tonnage of foliage will crowd out other combinations of plants resulting from past mismanagement. Foliage on range land in top condition is almost all forage.

Furthermore, the number of livestock that range land can profitably support depends more upon quantity than quality of forage. When protein and phosphorous content are adequate for good nutrition, a higher analysis with equal tonnage does not increase the number of livestock that can be carried; rather it carries the same number better. If the forage is deficient in quality we can add supplements but if the forage is short in quantity we are forced to reduce numbers grazed.

E. J. Dyksterhuis is Range Conservationist, U.S.D.A., Soil Conservation Service, Lincoln, Nebraska.



Differences in use alone caused the differences in these native pastures. Soil and climate are same. Proper use can make all look like top picture.

Excellent Range Condition

Taller grasses, such as GREEN NEEDLEGRASS, NEEDLEANDTHREAD, WESTERN WHEATGRASS, are abundant. These grasses, with an understory of BLUE GRAMA and JUNEGRASS, make up most of the ground cover. Seed is produced in favorable years. Good natural mulch accumulated on the surface lets water soak into ground faster. Forage production is at its highest and erosion is controlled.

Good Range Condition

BLUE GRAMA, a warm-season, short-growing grass, has partly replaced the taller, cool-season grasses. It now makes up a larger percentage of the cover than for Excellent Condition. When BLUE GRAMA replaces cool-season grasses the season of green grazing is shorter.

Fair Range Condition

Very few of the original taller-growing grasses remain. There is much bare ground, soil crusting and runoff. Rainfall is lost instead of stored for grass growth. Use of range conservation measures will restore POOR or FAIR condition ranges to EXCELLENT condition.

Poor Range Condition

Nature tries to keep the ground covered with something. When use is so heavy that taller growing grasses cannot survive, she substitutes cactus, annual weeds, or very short kinds of plants that can escape grazing.

S.C.S. No. 5,L-12,470

Figure 1. Reproduced here is an "information aid" showing a one-page translation of the ecological approach to range condition classes for the stockmen of a specific area. Conditions in four adjoining pastures on the same day are shown. Each pasture has the same kind of deep silty soil, under 14 inches of average precipitation in eastern Montana.

Secondary succession on ranges entails complex changes in plant cover, in microclimate, and in productivity of soil. The net result is improvement in the range condition for the site, measurable with certainty by changes in species composition. Succession to climax on range land does not exhaust the site, and cause the vegetation to become "sod-bound." Rather, the climax produces all the foliage the site is capable of producing on a sustained basis without cultivation or fertilizers.

The greater the departure of range vegetation from climax, the greater the exposure of the site itself to destruction by the elements, the greater the loss from the site of rainwater and snowmelt, and the greater the loss in average annual production of foliage. For these reasons range condition can be defined as "the percentage of the present vegetation which is climax vegetation for the site" (Fig. 1).

Determining Condition Class and Trend

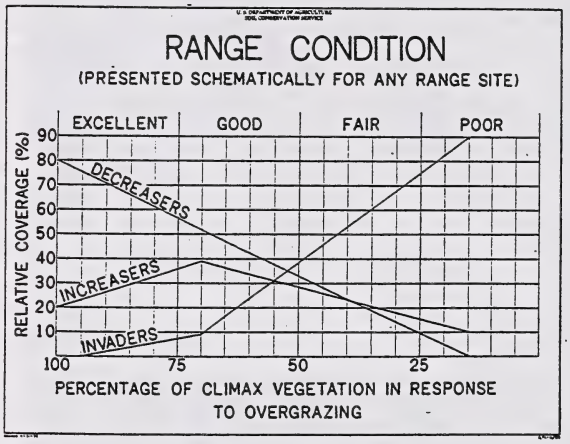
Range condition is classed as excellent on sites supporting 76 to 100 per cent of climax vegetation, as good with 51 to 75 per cent, as fair with 26 to 50 per cent, and as poor when a fourth or less of the current vegetation is of the kind found in the climax for the site. Short-term trends in condition, within these four broad classes, cannot be taken into account in recorded inventories of range resources nor in long-term planning. Condition class is measured by departure from 100 per cent climax vegetation, because there is no other point from which total deterioration of natural cover can be measured.

Grazing is managed to attain or maintain excellent or good range condition, rather than climax. The result on most sites is the climax *type* of vegetation, even though minor species are missing or poorly represented.

A quantitative procedure for determining the condition of ranges, and its background of researches and experience, was reported a decade ago (Renner, '48; Dyksterhuis, '49). Scientific bases recently were re-examined. This appeared advisable because of experience gained and rapid advances in related sciences. Advances in site classification were fostered by an increased understanding of climate, soil, and vegetation as continua; by better definition of climax; and by recognition of the ecosystem as the basic unit (Dyksterhuis '58).

In the development of a quantitative, rather than qualitative, classification of range conditions, it was and still is believed necessary to: (a) Distinguish between factors relating to trend in condition and factors determining a condition; (b) Integrate data from the sciences of descriptive climatology, cartographic edaphology, and vegetation science, under the climax theory, for practical range management; (c) Classify range sites by differences in their potential natural vegetation, rather than by differences in current types of vegetation; (d) Distinguish between lands with climaxes suitable for grazing use and lands with other climaxes such as forest; (e) Recognize economic considerations but not permit them to influence the ecological conception of the highest range condition for each site; (f) Make proper distinction between stages in primary plant succession and range condition classes; (g) Displace the time-honored classifying of range plants as either *weeds, grass and grasslike plants,* or *shrubs,* with a classification based objectively on response to grazing, namely, *decreasers, increasers,* and *invaders,* as measured from potential vegetation; (h) Displace the qualitative concept of "forage density" within a static vegetative type with a quantitative measurement of relative foliage production by species of a dynamic vegetation on a relatively stable site; and (i) Quantitatively determine condition by measuring departure from climax for specific types of sites rather than quantitatively describing selected conditions (Fig. 2).

Figure 2. Schematic diagram of relations between major variables used to classify range conditions.



Steps in the procedure include: (1) Mapping of sites based on soils differences within a climatic belt; (2) Mapping of range condition classes over the site as *excellent, good, fair,* or *poor,* depending upon percentages of *decreasers, increasers,* and *invaders* as related to climax vegetation for the kind of site; and (3) Determination of trend from current condition, by consideration of factors which permit either secondary plant succession (upward trend) or cause range degeneration (downward trend).

Since trends may change quickly and may originate from many causes, though usually from changes in weather or grazing intensity, they commonly are deduced from qualitative evidence. Thus, the trend on a range kept closely grazed from spring to late fall would unquestionably be downward even though the condition class remained the same. The trend on a range deferred

during a rainy growing season would be upward but change in kind of vegetation and, therefore, condition class, might not occur that year.

Ranchers can make qualitative appraisals of trends in different range pastures as a basis for prompt adjustments in grazing. Quantitative measurements of trends in range condition over periods of longer than a year provide data with many uses. A procedure has been devised and is widely applied (Parker, '51).

"Overgrazed" Means Unsatisfactory Range Condition

The term "overgrazed" can now have specific meaning. We have long been accustomed to calling weedy pastures "overgrazed"; weeds being plants out of place. We require no knowledge of the current stocking rate nor the degree of use to recognize an overgrazed pasture or range. Hence, "overgrazed" means unsatisfactory kinds and proportions of plants, considering what could grow on the site. It follows that the range condition classification provides a means of determining and stating specifically *how much* a pasture is overgrazed. In the range-condition system the amount of improvement possible is the exact reciprocal of the amount overgrazed. In other words, when fault is found the solution and degree of improvement possible is also pointed out.

Accordingly, it is more informative to name the condition class than to point out overgrazed areas. Excellent range condition means the site is not overgrazed, while good, fair, and poor conditions refer to three specific grades of past overuse that show today, but can be corrected through one, two, or three classes.

Overgrazing results from overutilization, and overutilization results from overstocking. An overstocked condition on a pasture can be corrected in a day by taking stock off. An overutilized condition can usually be corrected in a season by resting the pasture in the correct season the following year. Correction of an overgrazed condition requires at least two and often many years, depending upon climate and the degree of overgrazing as shown by the range condition class.

Improvement of an overgrazed range—that is, improvement in range condition—starts with a decision to stock the pasture at a rate to permit improvement. A choice between rapid or slow improvement must be made. A stocking plan serves the rancher much as the compass bearing serves the ship's captain between ocean ports. The rancher and the captain are seldom exactly on the planned figure, but nevertheless need such a guide because they must adjust to it to reach their objective.

Weather conditions cause great annual fluctuations in forage production and numbers must be adjusted seasonally to finish each grazing year with approximately the degree of use needed for the rate of improvement chosen. Light or no use at the end of the grazing season results in rapid improvement, moderate to full use results in slow improvement. Close or severe use one year can offset improvement of another year. Dry or cold seasons force adjustments in livestock grazing to offset changes in availability of pasturage, just as a ship's planned course is adjusted to offset sidewinds. Seasonal checks on degree of use should guide temporary departures from the long-time plan of stocking aimed at maintenance or improvement in range condition.

Intensity and Time of Grazing

A planned stocking rate is plainly not the equivalent of "grazing capacity" or "carrying capacity." The greater the difference between current and potential forage production on a site, the greater the difference between grazing capacity and the recommended stocking rate. Certain ranges may profitably be stocked far under carrying capacity to permit range improvement. Thus a very shallow site in excellent condition might be stocked heavier than a lowland site in fair condition even though the lowland site produced the most pounds of forage per acre and would easily carry the most livestock. Nothing would be gained by stocking the very shallow site below grazing capacity because the vegetation is already in top condition. Stocking the lowland site at capacity would mean that it would continue indefinitely to produce only about a third of what it could produce if managed so as to improve from the fair to the excellent condition.

Management of grazing includes suiting the *time* of grazing, as well as the intensity, to site and range condition. Ranges in poor condition are not only poor in total average forage production, but also in kinds of edible plants available through the year. As range condition improves, livestock can exercise more choice.

There are inherited differences among range species that determine the time of year within which each *can* grow rapidly. The differences are grouped very broadly when we refer to warm-season and cool-season plants. Grazing animals on native ranges systematically change the proportions of the various species that compose their diet through the year, because different species successively reach their zenith of growth, and then become fibrous, as the year advances. It is a truism that each species is most palatable and richest in protein, phosphorus, and carotene during the months when, by its inheritance, it grows most rapidly. Grazing management and any seasonal check on degree of use will have to take such species differences into account.

Of course, range livestock search eagerly for any green species when the bulk of the forage is brown. On native range in poor condition, there usually is no off-season green "picking" for livestock. But as such ranges improve to excellent condition, diversity of species, with

respect to season of growth, also increases. Hence, management of grazing should include rests in different seasons to increase both specific cool and specific warm-season plants. It is seldom economical to set stocking rates low enough under continuous grazing to permit recovery of species green in the off-season. Well-timed resting alternated with moderate stocking is a more feasible means of restoring excellent condition.

Appropriate seasons for resting and grazing are in some cases related directly to condition classes. For example, in true prairie climate, ranges in excellent condition can be maintained by grazing to full use (about one-half the growth) during the time of year when most rapid livestock gains are possible. This is the spring and early summer. Complete rest in the fall, to allow carbohydrate storage, is then adequate for maintenance of excellent condition. Deferment for seed production is not necessary because the stand is renewed vegetatively when in excellent condition.

In contrast, ranges in poor or fair condition cannot be even moderately used during the period the forage is most nutritious if the operator hopes to restore the range to its full production within a reasonable time. Rather, it is usually most practical to rest such ranges during the full growing season and to use the pasture for winter grazing with concentrates. Under this treatment the condition commonly improves one class every one to three years until excellent is reached.

On some ranges in poor condition class, a determination must be made if there are sufficient plants of the climax left scattered about to seed the area within a reasonable number of years. It must be kept in mind that first generation offspring of climax grasses are usually found within a rod of the parent. Therefore, it may not be economic to wait for natural revegetation on some ranges in poor condition. The choice between natural and artificial reseeding can sometimes best be made following a complete rest during a growing season. Then the ordinarily closely grazed choice species can be seen above the weedy invaders. This is often the only practical way to determine their distribution over the range and whether they are closely enough spaced for natural reseeding.

Brush Control and Range Condition

On ranges in poor or fair condition because of abnormal amounts of brush, a rest prior to clearing can show whether the expense of artificial reseeding should be included in the cost, or whether brush removal followed by one or two years of rest during the growing season will be adequate. During the season of rest prior to clearing, the climax perennials remaining will regain some strength and produce some seed with which to enter the race with the weeds for the area bared in brush clearing.

On some range sites certain woody species were always present and amounts up to that normal in the climax vegetation for the site would not lower the range condition class. Constant reclearing is necessary to maintain such pastures if less than normal amount of brush is desired.

Thinning of the brush to an amount normal for a site can often be maintained by management of grazing alone. On some sites, however, the equivalent of the original fire influence may have to be added. Either or both methods may be much more economical than mechanical maintenance of a cleared area. Normal equilibrium in competition between grass and brush occurs in the excellent condition. Unbalance between grass and brush brought about through overuse by grass eaters should not be replaced by an unbalance brought about by the overuse of brush killers.

Summary

Range condition classification is a basis for planning ahead several years to economically increase production of native forage on each kind of range land (sites). For the individual operator this entails long-term decisions, such as size of breeding herd. By contrast, checks on degree of use affect short-term decisions, such as whether to sell or hold young stock and whether to hold or use emergency feed reserves.

The amount of the current production that *has been grazed* is expressed as a degree of use. Proper use from year to year on natural pasture lands permits range improvement through natural plant succession to the point where a type of vegetation in equilibrium with the soil and climate is reached. Site and range condition class determine what a range *can be expected to produce now,* and in the *future,* under various seasons and intensities of grazing.

Today, we can quantitatively determine range condition on many types of sites by relating current species composition to that of the climax. With such knowledge of both current and end product, we can adjust time and intensity of grazing to meet the needs of species higher in secondary succession. Moreover, since *change* in species composition is the indicator of succession, these changes can actually measure the amount of range improvement that results from different kinds of management.

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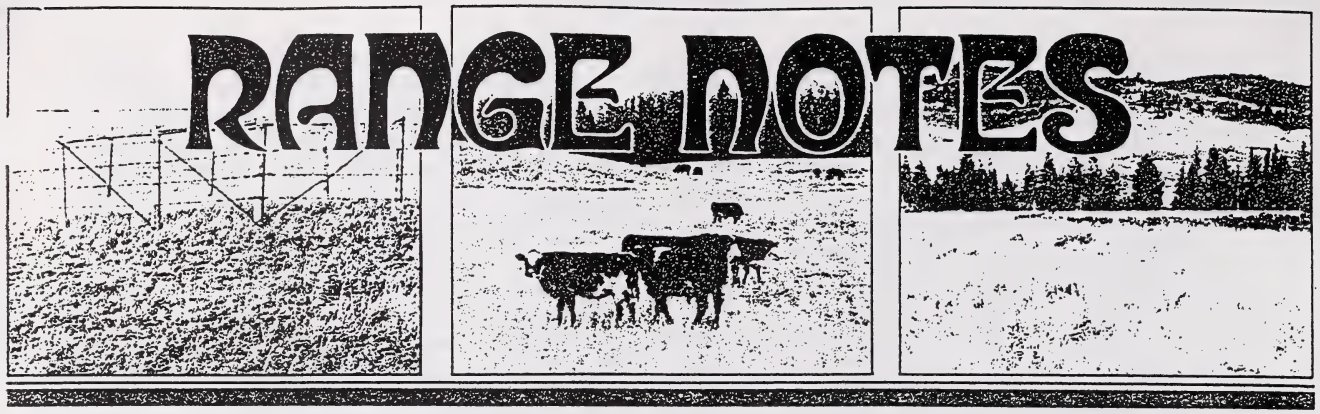
APPENDIX 4

RANGE NOTE, ISSUE #5

THE ANIMAL UNIT (AU) - ADJUSTING FOR LARGER COWS



Issue No. 5 January, 1990

The Animal Unit (AU) - Adjusting For Larger Cows

Introduction

Producers that lease public grazing land from Alberta Public Lands will note the 1989 stock return form has changed. This year's form asks for more information about livestock and management. The new changes will help you to better monitor the long-term productivity and management of your grazing lease or permit.

Balancing livestock needs with the available forage supply is a basic principle of range management and is essential for a successful grazing program. The **Animal Unit (AU)** concept helps the grazing manager to match the numbers, classes and sizes of livestock grazed (stocking rate) with the land's capacity to supply forage (carrying capacity). The purpose of this **RANGE NOTE** is to review the **AU** concept and how it relates to management of your grazing lease or permit.

The Animal Unit and the Animal Unit Month

Alberta Public Lands administers grazing on 6500 leases and permits covering 5.7 millon acres throughout the province. Accordingly, there is a wide range in kinds, classes and sizes of animals grazed. A common unit of measurement is needed to match livestock needs with forage available in a pasture. This is achieved by defining a ***standard animal*** that can then be adjusted for differences in kind, class and size of animal.

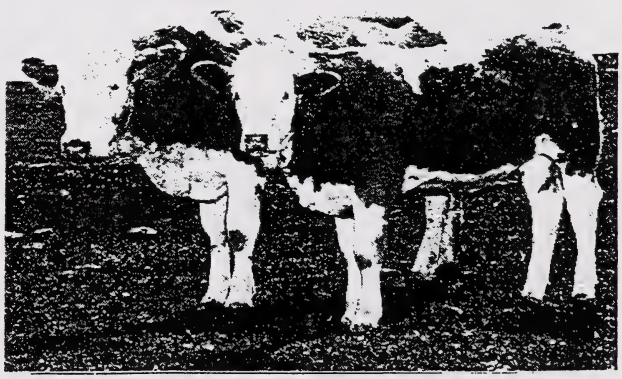
The **Animal Unit (AU)** defines the daily forage intake relative to the ***standard animal.*** In grazing terms, the ***AU***[1] represents one mature cow of approximately 1000 lb., either dry or with a calf up to six months of age. The 1987 edition of *Beef Cattle Allowance Tables,* published by Alberta Agriculture, specifies that such a cow, nursing a calf, would need 24 Mcal/day of energy or 24 lb./day of native grass (1.0 Mcal/lb. of dry matter).

[1] Source: Glossary of Terms Used in Range Management, 1989, Society for Range Management.

The **Animal Unit Month (AUM)** is the amount of forage required by an AU for one month and is usually set at about 1000 lb. of forage dry matter. This number includes the 720 lb. of forage dry matter (24 lb./day x 30 days) required for consumption, which is then rounded up to 1000 lb. by assuming a roughly 25% forage loss that is due to trampling and wastage.

Animal Unit Equivalents

Livestock which consume more or less forage dry matter than the **standard AU**, because of kind, class or size are given Animal Unit equivalents such as those listed in Table 1. These values reflect the animals intake relative to the ***standard animal.*** For example, bulls require more feed than the standard cow-calf pair and are rated at 1.5 AU while weaned calves require less and are rated 0.5 AUs.



Although crossbreeding has changed the frame size of the modern cow and calf, the AU concept remains a valuable tool for matching livestock needs with the available forage supply.

Range Notes is published periodically to share findings and recommendations arising from applied research carried out by the Range Management Unit. Range Notes is intended primarily for managers of public grazing lands.

For more information contact any of the following Public Lands Division offices:

- 530-8 Street S., Lethbridge T1J 4C7 (403) 381-5486
- 182-Chippewa Road, Sherwood Park T8A 4H5 (403)464-7955
- Box 1959, Eldorado Bldg., St. Paul T0A 3A0 (403) 645-6336
- Box 35, Provincial Bldg., Peace River T0H 2X0 (403) 624-6290

To call toll free, check your AGT directory under Government of Alberta.

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FORESTRY, LANDS AND WILDLIFE
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TABLE 1. Animal Unit Equivalents for Cattle, Horses, Sheep and Goats.

	AU
Cattle:	
Weaned calves	0.50
Yearling heifers and steers	0.75
Mature 1000 lb. cow, either dry or with calf up to six months of age	1.00
Bulls, two years and older	1.50
Horses:	
Yearlings	0.75
Two-year olds	1.00
Three-year olds and older	1.50
Sheep and goats:	
15 unweaned lambs and kids	1.00
6.5 weaned lambs, kids and yearlings to 12 months	1.00
5 ewes or does	1.00
5 rams or bucks	1.30

Source: Values used by Public Lands Division, Alberta Forestry, Lands and Wildlife.

The Modern Cow and Calf - Adjusting for Size

Recent drought conditions, experienced throughout much of the province, have forced managers to take a closer look at stocking rates. One key factor is the effect that crossbreeding has had on animal size. A generation ago, most cows were of the traditional British breeds, weighed 750 to 950 lb. and weaned a 350 lb. calf. Crossbreeding programs with mostly continental-European breeds have increased cow size to an average of 1200 to 1300 lb. The range in cow weights extends from 1000 to 1600 lb. These larger cows require more energy for maintenance and for greater milk production.

Calves are bigger too. The genetic changes that boost cow size also yield a larger-framed calf. This calf size combined with a general shift towards earlier calving, clearly suggests the modern calf requires more nutrition than the standard calf. **The bottom line is that bigger cows and heavier calves graze more grass, so adjustments need to be made when matching livestock needs with available forage.**

Critical factors to consider are cow size (live weight), milk production level and calf size. In Table 2, the energy requirements of the 1000 lb. AU with standard milking ability and an average calf are compared with those of a large 1500 lb. cow and her calf. The comparison is somewhat extreme; nonetheless, it illustrates the effect that genetics can have on feed requirements. A 1500 lb. cow will require 33% more energy. If she is a heavy milker as well, she will need 58% more energy. Add to that a large-framed calf (500 lb.) and energy needs rise to 71% more than the standard cow. **The forage required is more or less proportional to the increase in live weight, particularly when you consider that, generally, larger cows will be heavier milkers and raise larger than average calves.**

TABLE 2. Effect of cow size, milk production and calf size on energy requirements.[1]

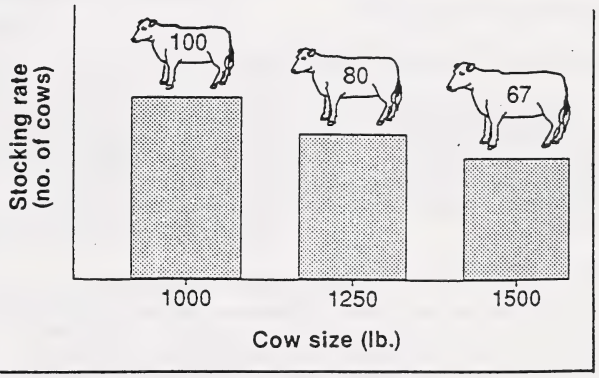
Cow Class	Energy/Forage Requirements (Mcal/d or lb./d)[2]	(%)[3]	(AU)
1000 lb. cow standard milker & average calf	24	100	1.00
1500 lb. cow[4] standard milker & average calf	32	133	1.33
heavy milker & average calf	38	158	1.58
heavy milker & larger calf	41	171	1.71

[1] Adapted from Beef Cattle Allowance Tables, 1987, Alberta Agriculture.
[2] Assumes forage has 1.0 Mcal/lb. of dry matter.
[3] % of energy/forage requirements based on the 1000 lb. cow as the standard.
[4] Standard milker produces 10 lb./d, heavy milker produces 20 lb./d; average calf weighs 300 lbs., large calf weighs 500 lb.

If producers stock their grazing leases with the same numbers of these larger animals as they once did with standard-sized animals, and if they do not reduce the grazing period appropriately, overgrazing will result. The total livestock demand for forage will exceed the capability of the land to supply forage and the grazed rangeland will suffer. **A practical solution is to adjust for changes in cow size on an Animal Unit equivalent basis by adding 0.1 AU for every 100 lb. increase in live weight above the standard AU.** For example a 1250 lb. lactating cow would constitute 1.25 AU. Figure 1 shows how this adjustment for cow size would be put into practice for 1000 lb., 1250 lb. and 1500 lb. lactating cows with calves. The pasture with a carrying capacity of 100 AUMs would provide one month of grazing for 100, 80, and 67 head, in the preceding weight classes. This simple adjustment can also be applied to other classes of stock.

FIGURE 1

The number of cows that can graze a field with a carrying capacity of 100 AUMs, for one month, declines as cow size increases.



Additional research is necessary to determine the effect of both early calving and increased calf size on the forage requirements of the modern calf. In addition to the nutrition that calves receive from milk, calves will graze a considerable amount of forage by weaning time. Calves may graze within 30 to 60 days of birth as they begin to nibble grass and mimic their dams. By two months of age they can consume 1 lb. of forage dry matter per day and by weaning about 12 lb./day. Over a 5.5-month grazing season about 1000 lb. of forage may be consumed. A series of new studies undertaken by Agriculture Canada will measure forage intake by the modern calf in relation to the size and milking ability of the modern cow.

Carrying Capacity and Stocking Rate Are Not the Same

Total AUMs represent the ***carrying capacity*** or the ***long-term average grazing*** that is available in an average year on your lease with good grazing management. Carrying capacities are determined from range surveys, grazing or clipping studies and experience based on stocking records. Carrying capacity includes consideration of livestock (and wildlife) forage needs, as well as an adequate carryover. Carryover is the part of one year's grass crop that is left ungrazed to protect plants and soil. Carryover, combined with any regrowth produced after grazing, will restore plant food reserves, will help conserve precious moisture and protect the soil from wind or water erosion. So the long-term carrying capacity is set at a level that will maintain the forage vigor and productivity characteristic of good to excellent range condition.

The actual numbers of animals grazed is referred to as the ***stocking rate.*** Good management normally ensures that stocking rate is the same as carrying capacity. In moist years when forage growth is above average, surplus grass will build plant vigor and litter (weathered carryover) to offset the years that are on the dry side. Stocking rates should be reduced, so that plants and soil are not damaged, when drought hits (as in 1988), when grazing management is not adequate, or when local needs of wildlife species such as pronghorn antelope, elk and deer must be accommodated.

'Good Range Management"

It's More Than Proper Stocking Rate!

Balancing livestock needs with the available forage supply is a basic goal and principle of range management. But grazing lessees need to consider many other management practices to conserve soil and vegetation and to sustain forage productivity. Future issues of RANGE NOTES will examine these principles and practices in more detail, but here are a few:

Distribute Livestock Evenly:

Cattle are selective grazers, so when left to make their own choices they will graze and regraze the same plants and, as grazing lessees know, "if you keep down the shoot you will kill the root." Eventually range plants lose vigor and productivity. Managers need to use salting, water development and fencing to promote uniform grazing.

Delay Spring Grazing:

Most native rangelands, be they short grass prairie or northern woodland, will benefit from the delay or deferral of spring grazing. During spring, native plants are vulnerable to grazing as they draw upon stored food reserves to produce new leaves and seed stalks. Native range can be protected by delaying use until the range is ready (usually mid-May to mid-June), by using seeded pasture for spring grazing instead or by alternating the early grazing period between two or more fields.

Provide Periods of Effective Rest:

All range and pasture plants require periods of effective rest after being grazed - to regrow, to replenish food reserves and at times to produce and set seed. Effective rest occurs when growing conditions allow adequate shoot and root growth. Rest is normally provided by rotational grazing systems where each field is grazed for a period according to a plan or schedule and then livestock are removed to provide the rest and recovery period.

Monitor Your Rangeland:

Many factors can affect forage production on your lease. It helps to know what's happening as the result of your grazing management and other factors such as rainfall and general growing conditions. Collecting and recording information about stocking rates, range condition, rainfall, grazing patterns and problem areas is called monitoring. Monitoring will help you to plan and implement changes in grazing management when the need arises.

Land Resource Agrologists administer public lands in your district and periodically inspect these lands and review grazing management with you. They are trained in range management and are available to assist you. If you need some advice, or have any questions about your grazing lease, please call your District Agrologist or drop in to one of our offices.

Prepared by Range Management - Public Lands Division

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SAMPLE CALCULATIONS

EXAMPLE 1:

Grazing lease ..... 640 ac.
Carrying Capacity ..... 210 AUMs
Livestock: type, numbers, size
Cow-calf pairs (avg. cow weight - 1000 lb.) 75
Bulls 3

Question:

How many AUs and how long can the herd graze the lease?

Answer:

75 cow-calf pairs x 1.0 AU 75.0
3 Bulls x 1.5 AU 4.5
Total AUs 79.5

$$\frac{210 \text{ AUMs}}{79.5 \text{ AUs}} = 2.6 \text{ months or } 79 \text{ days}$$

EXAMPLE 2:

Grazing lease ..... 1280 ac.
Carrying Capacity ..... 340 AUMs
Livestock: type, numbers, size
Cow-calf pairs (avg. cow weight - 1300 lb.) 105
Bulls 4
Yearlings (avg. yearling weight - 900 lb.) 33

Question:

How many AUs and how long can the herd graze the lease?

Answer:

104 cow-calf pairs x 1.3 AU 136.5
4 Bulls x 1.5 AU 6.0
33 yearlings x 0.9 ..... 29.7
Total AUs 172.2

$$\frac{340 \text{ AUMs}}{172.2 \text{ AUs}} = 1.9 \text{ months or } 59 \text{ days}$$

APPENDIX 5

WAINWRIGHT DUNES HISTORY,

MAP OF REGISTERED OWNERS OF LANDS IN AND AROUND WAINWRIGHT DUNES 1900 - 1921,

AND

EXCERPT FROM COUNTY MAP (ABOUT 1930)

(Maps available in Public Lands Office, Wainwright)

WAINWRIGHT DUNES HISTORY

(Information compiled from 1992 interviews with Mr. and Mrs. Bob Brown who lived in SE 32-41-5-W4M during the early 1900's.)

Early settlers from Daisy, Iowa, scouted this area in 1910. When they came upon this Parkland, the grass was high and lush. The beauty of this wild country with its meadows, lakes and high sand hills enticed them to send for their families. Among these early pioneers were the Sullivans, Lawsons, Coonc's and Browns.

In these early years, there were families every 3 mi. with each operating a half section of land. There was a school district located every 6 mi. The Daisy school, located on Section 29, Township 41, Range 5, opened in 1913 and had approximately 25 students. A wagon trail went from the Daisy school to Ray's (David) Lake. Settlers picnicked under the large trees that grew by the edge of the lake, picked berries and hunted mule deer along this trail. But had to keep their eyes open for the poison ivy found all along the dunes.

This was saddle horse country at that time, and farmers depended on horses for all their farm work and for transportation. The dunes area was used as open range for horses as well as cattle.

"Juniper Hill" is located in Section 33, Township 41, Range 5, and was the popular lookout for spotting cattle. The hill is the highest in the area and has three juniper trees on top.

In the early days, it was easy to ride this range because the land was relatively clear of bush; this could have been a result of a fire sweeping through the area in about 1906. At the Northeast corner of Ray's Lake where tall trees grew and pure water trickled from a spring.

In the early '20s, Indians camped at the lakes in Sec 29, Twp 41, Rge 5, just south of the E.R. They came in the spring and trapped muskrats. By 1926, the Indian camps started disappearing. Indian artifacts (buried pemican bags) have been found in the area and along the Ribstone Creek. There was evidence that buffalo grazed this area as skulls were spotted all over the countryside with a high concentration found on Ray's Lake.

In approximately 1926-'27, a caterpillar plague killed many of the poplar trees in the region. This deadfall was cleaned out by the people of the area and used for firewood. Many trails were made through the Dunes area as people picked up the deadfall.

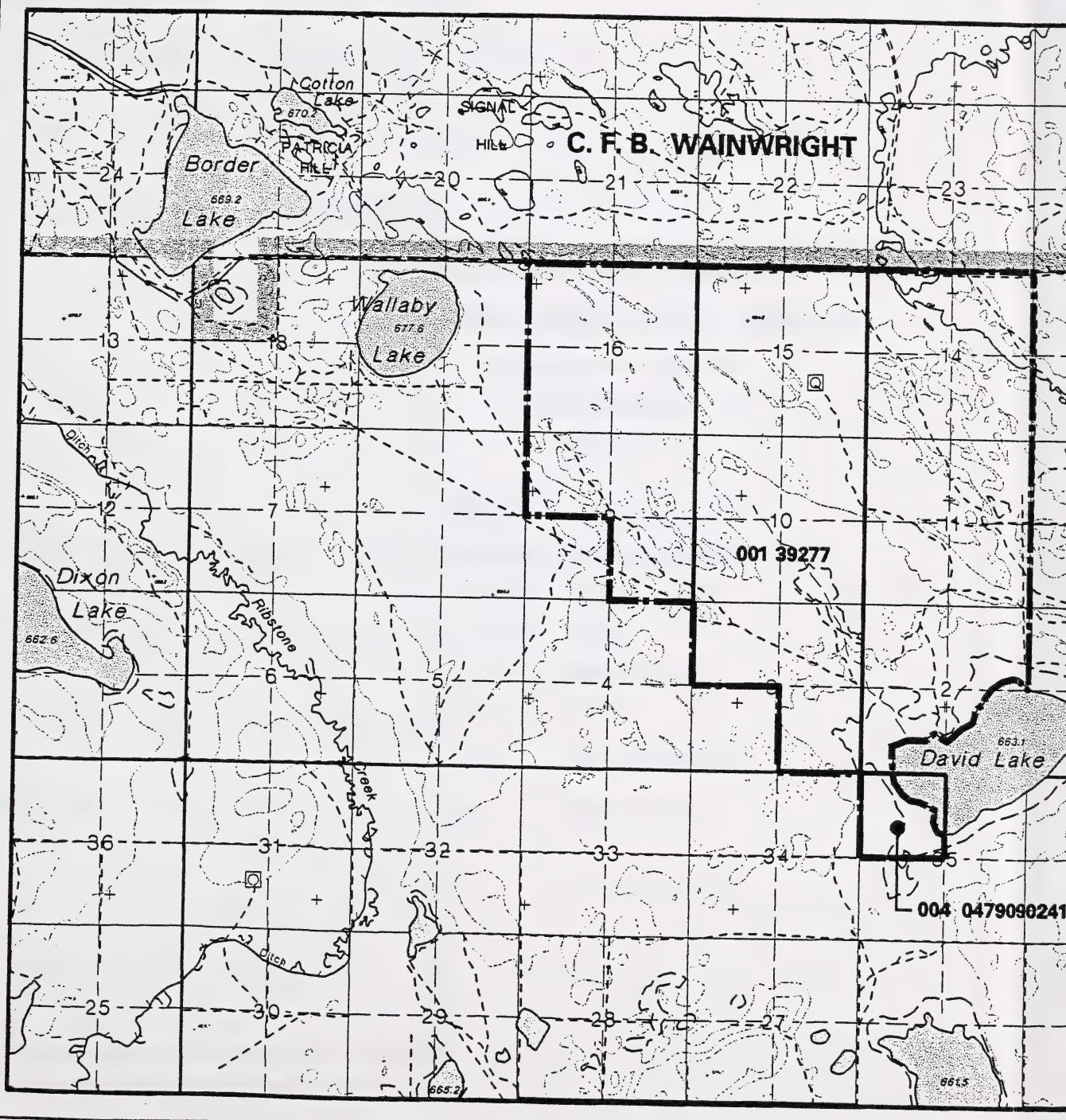
By the 1930s, the region was in a drought. Ray's Lake was bone dry, and you could ride across it. This drought continued for approximately 18 years until 1948 when the area was blessed with 4 ft. of snow and winter that lasted till April.
The runoff flooded the rangeland and refilled the scorched, cracked sloughs.

Even though the precious moisture finally came, it was too late for most of the early settlers; they had left the area seeking better land or urban jobs. Where once a homestead stood every three quarters now there were none.

During the war, a bounty of $10 per ton was put on dried animal bones. These bones were shipped to Washington and California by rail, where they were ground into powder and used for making ammunition. The countryside was rapidly cleaned up as people saw a new way to earn the needed dollar. All visible bones were picked up and taken to the elevator at Czar. There they were purchased by the agent, Don Brown. Unfortunately, the American companies did not want buffalo bones. They were separated from the others and returned to the gatherers to be dispersed as they saw fit. It is possible that these "valueless" bones ended up piled in garbage pits or in sloughs, or just thrown by the side of the road. Sadly, the evidence of a once great nomad was wiped clean from the dunes area. Today only the abandoned homesteads remain.

APPENDIX 6

MAP OF WELLSITES AND LAND DISPOSITIONS


C. F. B. WAINWRIGHT
Cotton Lake
670.2
PATRICIA HILL
SIGNAL HILL
Border Lake
669.2
Wallaby Lake
677.6
Dixon Lake
662.6
Ribstone Creek
Ditch
Ditch
David Lake
663.1
001 39277
004 0479090241
665.2
661.5
24
20
21
22
23
13
18
16
15
14
12
7
10
11
6
5
4
2
36
31
32
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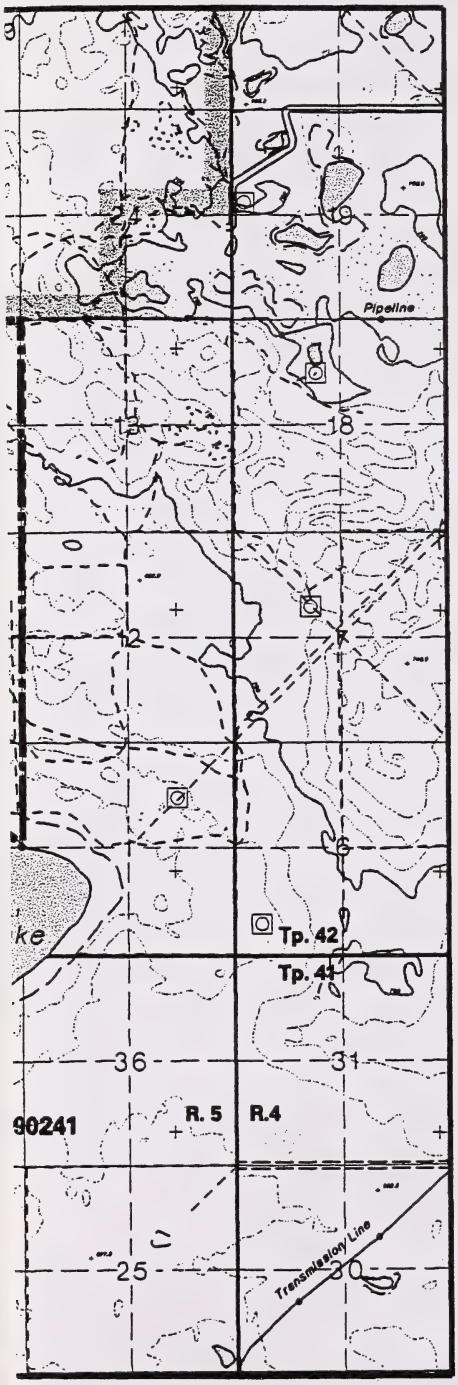
27



WAINWRIGHT

CANDIDATE ECOLOGICAL RESERVE

Tp. 41 and 42 – R. 5 W4

MAJOR DISPOSITIONS

SCALE 1:50 000

Legend

STUDY AREA BOUNDARY

DISPOSITIONS SHOWN ARE
MINERALS DIVISION PNG LEASES.
ENTIRE AREA ALSO UNDER
PUBLIC LAND DIVISION
GRAZING LEASE 38839.


C. F. B. WAINWRIGHT
Cotton Lake
670.2
SIGNAL HILL
PATRICIA HILL
Border Lake
669.2
Wallaby Lake
677.6
Ditch
Dixon Lake
662.6
Ribstone Creek
David Lake
663.1
Ditch
665.2
661.5
24
20
21
22
23
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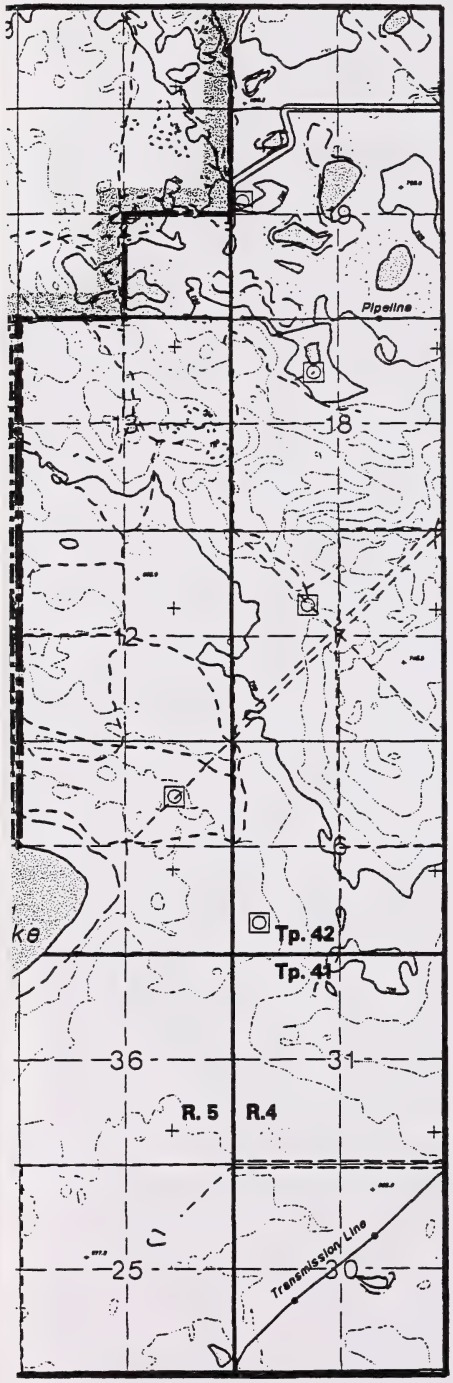
36
31
32
33
34
25
30
29
28
27



WAINWRIGHT

CANDIDATE ECOLOGICAL RESERVE

Tp. 41 and 42 – R. 5 W4

DISTURBANCES

SCALE 1:50 000

Legend

- STUDY AREA BOUNDARY
- ROADS
- FENCES
- SEISMIC LINE
- DUGOUT
- A — WELL SITE (Abandoned)
- C — WELL SITE (Capped)

APPENDIX 7

TERMS OF REFERENCE FOR WAINWRIGHT

DUNES ECOLOGICAL RESERVE

MANAGEMENT PLAN

APPENDIX 7

TERMS OF REFERENCE FOR WAINWRIGHT DUNES ECOLOGICAL RESERVE MANAGEMENT PLAN

Terms of Reference for
Wainwright Dunes Ecological Reserve
Management Plan

September 1988

Ecological Reserves
Co-ordinating Committee

1. INTRODUCTION

This document constitues the terms of reference to be used in the development of the Wainwright Dunes Ecological Reserve Management Plan. Its purpose is to outline the intentions of the plan. Firstly, this document will describe the process involved in plan development and the groups and agencies identified to date who will participate in plan development. Secondly, the terms of reference will outline the contents of the plan and identify the major issues. Finally, a tentative schedule will be outlined for completion of a draft management plan.

1.1 Purpose of the Ecological Reserve System

Ecological reserves are established under the Wilderness Area, Ecological Reserves and Natural Areas Act (WAERNA) RSA 1981 to preserve lands for ecological purposes. They are protected natural landscapes set aside to preserve in an undisturbed state representative examples of the natural regions of Alberta. The prime objective is to achieve representation of Alberta's natural landscapes and the genetic diversity they include. As outlined in the Act, ecological reserves may include:

- lands suitable for scientific research associated with the study of natural ecosystems;
- representative examples of natural ecosystems;
- examples of ecosystems modified by man which offer opportunities for studying their recovery;
- areas containing rare or endangered plants or animals;
- areas which contain unique or rare examples of natural or biological features.

Ecological reserves are strictly protected to ensure that the natural features they contain are maintained in the long-term.

1.2 Ecological Reserve Selection and Establishment

The Wainwright Dunes area was first recognized as worthy of consideration as an ecological reserve in the 1970's. Through extensive interagency review, a proposed boundary was agreed on and a protective reservation placed in 1979. Subsequent studies done on the area (Fehr 1984, Cottonwood Consultants 1986) confirmed its value.

In 1987, the Advisory Committee on Wilderness Areas and Ecological Reserves held an open house to discuss the proposed ecological reserve with interested individuals and public groups. As a result of those discussions, the Advisory Committee recommended to the Ministers of Alberta Recreation and Parks and of Alberta Forestry, Lands and Wildlife that the area be established as an ecological reserve. As required by the Act (Section 3.1(3)), public notice of the intent to establish was placed in the Alberta Gazette and appropriate newspapers. On January 14, 1988, the site was established by Order-in-Council O.C. 39/88.

2. OVERVIEW OF THE WAINWRIGHT DUNES ECOLOGICAL RESERVE

Wainwright Dunes Ecological Reserve is within the Central section of the Aspen Parkland Natural Region. This is a natural region which is essentially unique to Western Canada, but which has been heavily altered by land use. Probably less than 5% of the natural region remains in its natural state. This natural region is not well represented in either federal or provincial 'protected area' systems (Cottonwood 1986).

Wainwright was chosen because it is one of the few relatively large natural sites remaining in the Central Parkland. It includes both representative features of Parkland on sandy terrain as well as special features. Most notable are the fens; comparable wetlands have not been found elsewhere in the Parkland. For a more comprehensive listing of special and representative features, see Cottonwood 1986.

The Wainwright Dunes Ecological Reserve is located in east-central Alberta, about 23 km southeast of the town of Wainwright as outlined in Figure 1. It is about 2 820 ha in size (Figure 2) and includes the following lands:

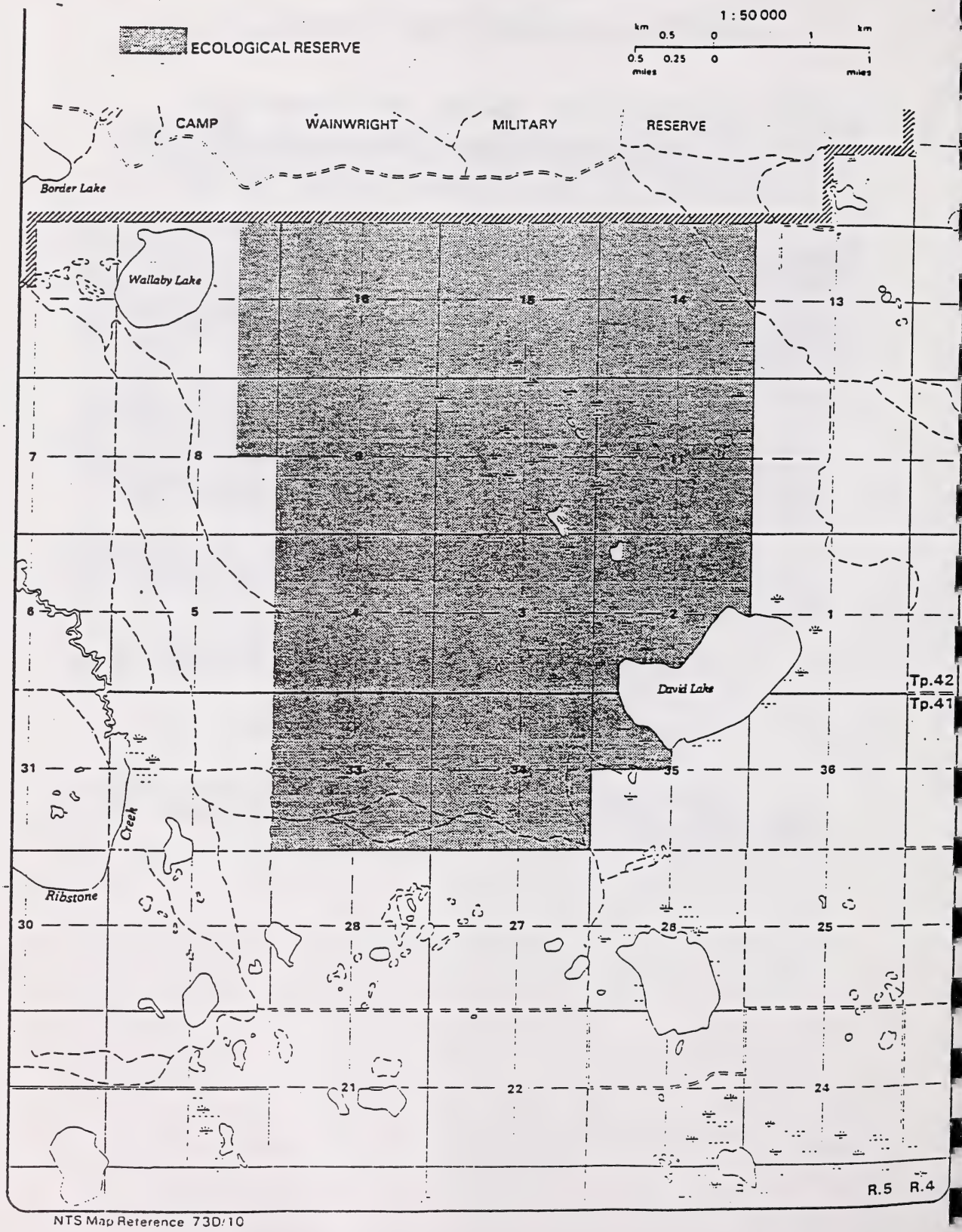
Township 42 Range 5 West of the 4th Meridian
2, 3, 4, LS 9 and LS 16 of 8, 9, 10, 11, 14, 15, 16 and LS 1, LS 8, LS 9 and LS 16 of 17

Township 41 Range 5 West of the 4th Meridian
33, 34 and NW1/4 35

The management plan for the ecological reserve will focus on these lands but may include management recommendations for a surrounding buffer area.

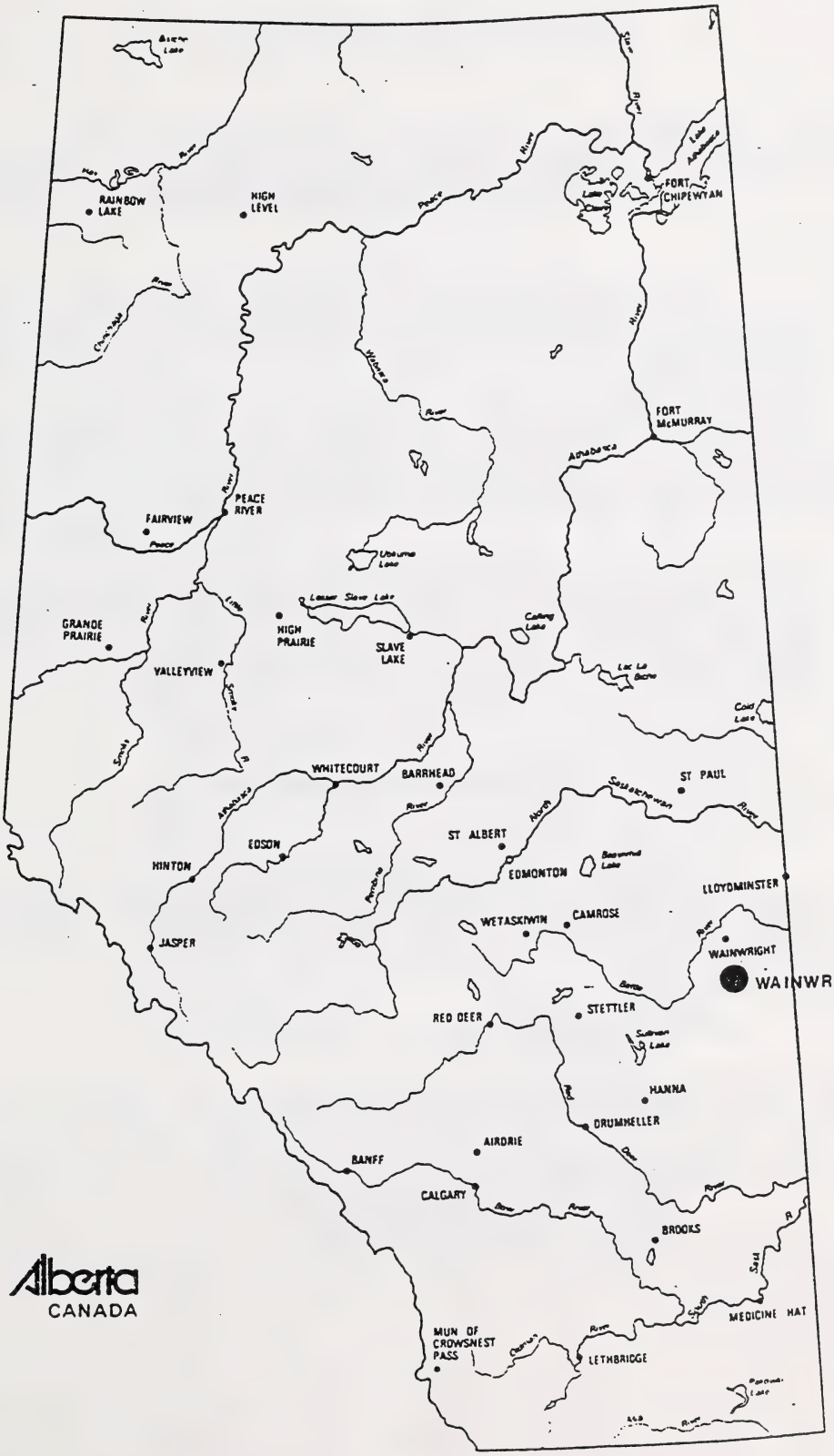
FIGURE 2 **WAINWRIGHT DUNES**

Tp.41 and 42, R.5 West of 4th Meridian



NTS Map Reference 73D/10

FIGURE 1 WAINWRIGHT DUNES



3. PREPARATION OF THE WAINWRIGHT DUNES ECOLOGICAL RESERVE MANAGEMENT PLAN

The management plan will provide direction for the management and use of the reserve to ensure that the natural values are protected and maintained. This plan will be developed following the process outlined in Figure 3.

3.1 Preparation of Terms of Reference

The terms of reference for the Wainwright Dunes Ecological Reserve was developed by the Public Lands Division of Alberta Forestry, Lands and Wildlife. Once reviewed and approved by the Ecological Reserves Co-ordinating Committee, the planning team will be struck and the plan initiated.

3.2 Management Planning Team

A management plan will be developed by the Public Lands Division in consultation with the involved government agencies and groups. Those identified to date who will be requested to participate in the development of the plan include:

Government Agencies
- Recreation and Parks
- Fish and Wildlife
- Camp Wainwright
- Municipal District of Provost #56

Public Groups
- Local Fish and Game Associations
- Buffalo Park Grazing Association
- Alberta Wilderness Association
- Interested or affected individuals, groups and companies

3.3 Data Collection and Assessment

Data pertinent to the site should be identified and reviewed. Priority conservation features should be identified and data gaps noted. Additional data collection may be required before some issues can be dealt with satisfactorily.

3.4 Issue Identification

Issue identification will be done through discussions with interested and affected groups and individuals, both public and private. From this, key issues will be identified and minor issues listed. Any management strategies developed must be consistent with the objectives and prohibitions for ecological reserves as set out in the WAERNA Act (Appendix I).

The following issues have been identified to date, and must be addressed in the management plan:

- brush and aspen encroachment
- buffer zones
- grazing
- range improvement
    - dugouts
    - fencing
- horse use
- hunting
- petroleum and natural gas extraction
- rare species protection
- reclamation of disturbances
- recreation use
- trapping
- vehicle access
- weed control
- fire/disturbances from Camp Wainwright exercises

These issues have been identified either in the studies that have been done on site, or through comments made by agencies and public groups. Other issues will undoubtedly be identified as the plan progresses. In addition, there are several issues which must be addressed for all ecological reserves, as outlined in Nuxoll (1986).

3.5 Draft Management Plan

A draft management plan will be developed using Nuxoll (1986) as a guide.

3.6 Plan Review and Approval

Once a draft plan is completed, it will be reviewed by the Ecological Reserves Co-ordinating Committee (ERCC) and then sent out for final comment to the participating groups and agencies. Based on the comments received, the final draft plan will be developed and submitted to the ERCC. The steps for approval and implementation are outlined in Nuxoll (1986) and summarized in Figure 4.

3.7 Plan Implementation

Once the final plan is approved, the managing agency will implement the plan. This process will include the following:

- staff meetings;
- incorporation of Ecological Reserves Management Plan into the work plan;
- communication with key stakeholders (nearby residents);
- budget submissions as needed.

Monitoring of the Wainwright Dunes Ecological Reserve will be the responsibility of the Public Lands Division. Monitoring includes observing any activities within and in the vicinity of the reserve boundary, updating head office and the ERCC on an annual basis and identifying any new issues.

3.8 Plan Review and Revision

As new information is brought forward or new issues are identified, the plan may require review and revision. Revision should be done as required and through the consultation process used to develop the initial plan. As a minimum, the plan should be reviewed every three years to ensure it remains workable and applicable.

4. CONTENTS OF THE PLAN

As a guideline, the management plan will follow the process and format set out in "Ecological Reserves: Management Plan Format and Process" (Nuxoll 1986). It will provide the policy and management direction to maintain and preserve the representative features within the Wainwright Dunes Ecological Reserve. Any recommendations must be consistent with the objectives and prohibitions for the ecological reserves as set out in the Wilderness Areas, Ecological Reserves and Natural Areas Act (RSA 1980).

The purpose of the reserve, boundaries, permitted uses, any transfer of management responsibility, financial implications and a program for resource management and rehabilitation will be outlined in the plan.

The plan will further include, but not be limited to:

- a statement of the objectives or purposes of the reserve, including its role in the reserves system;
- a policy statement regarding research, education, public use, access, facility development and resource management;
- programs and plans for fire and disease control, resource protection and rehabilitation;
- a resource inventory compendium of available and required information;
- research, monitoring and other needs, including identification of data gaps.

5. COMPLETION SCHEDULE

It is anticipated that a final plan will be completed for review within eight to 12 months of initiation of the management plan. Once the management plan has been initiated, the planning team can develop a more detailed schedule for the ERCC.

REFERENCES CITED

Cottonwood Consultants Ltd. 1986 The Proposed Wainwright Ecological Reserve - A Biophysical Overview. Alberta Recreation and Parks, Edmonton.

Fehr, A. 1984. Wainwright Study Area - A Biophysical Inventory. Alberta Energy and Natural Resources Technical Report T/65. Edmonton.

Nuxoll, R. A. 1986. Guidelines for the Preparation of Management Plans for Ecological Reserves. Alberta Recreation and Parks, Edmonton.

Wilderness Areas, Ecological Reserves and Natural Areas Act. Revised Statutes of Alberta 1981, Chapter W-8. Queen's Printer, Edmonton.

APPENDIX 8

PLANT SPECIES KNOWN TO OCCUR IN THE WAINWRIGHT DUNES ECOLOGICAL RESERVE

WAINWRIGHT DUNES ECOLOGICAL RESERVE

VASCULAR PLANTS

(species list obtained from Cliff Wallis (1988), Patty Cotterill (1992) and J. Derek Johnson (1992)

agrimony - *Agrimonia striata*
alder, river - *Alnus tenuifolia*
Alexanders, heart-leaved - *Zizia aptera*
alumroot, Richardson's - *Heuchera richardsonii*
anemone, cut-leaved - *Anemone multifida*
anemone, Canada - *Anemone canadensis*
anemone, long-fruited - *Anemone cylindrica*
arrow-grass, seaside - *Triglochin maritima*
arrowhead, arum-leaved - *Sagittaria cuneata*
aspen - *Populus tremuloides*
asphodel, sticky false - *Tofieldia glutinosa*
aster, golden - *Heterotheca villosa*
aster, Lindley's - *Aster ciliolatus*
aster, marsh - *Aster borealis* *
aster, smooth - *Aster laevis*
avens, three-flowered - *Geum triflorum*
avens, yellow - *Geum aleppicum*

baneberry, red and white - *Actaea rubra*
barley, foxtail - *Hordeum jubatum*
bean, golden - *Thermopsis rhombifolia*
bearberry, common - *Arctostaphylos uva-ursi*
bedstraw, small - *Galium trifidum* *
bedstraw, sweet-scented - *Galium triflorum*
bedstraw, northern - *Galium boreale*
beggarticks, nodding - *Bidens cernua*
begonia, wild - *Rumex venosus*
birch, dwarf - *Betula pumila*
birch, white - *Betula papyrifera*
birch, water - *Betula occidentalis*
bishop's-cap - *Mitella nuda*
bladderpod, sand - *Lesquerella arenosa*
bladderwort, common - *Utricularia vulgaris*
bladderwort, flat-leaved - *Utricularia intermedia*
blazingstar, meadow - *Liatris ligulistylis*
blite, strawberry - *Chenopodium capitatum*
bluebur, western - *Lappula occidentalis*
blue grama - *Bouteloua gracilis* *
bluegrass - *Poa* sp.
bluegrass, fowl - *Poa palustris*
bluegrass, inland - *Poa interior*
bluegrass, Kentucky - *Poa pratensis*
bluets, long-leaved - *Houstonia longifolia*
bog orchid, blunt-leaved - *Habenaria obtusata*
bog orchid, tall white - *Habenaria dilatata*

brome, awnless - *Bromus inermis* *
broom-rape, clustered - *Orobanche fasciculata*
buck-bean - *Menyanthes trifoliata*
buckbrush - *Symphoricarpos occidentalis*
buffaloberry, Canada - *Shepherdia canadensis*

* Plant species found by J. Derek Johnson, July 29, 1992 (Most of these species were found in the area of the large fen complex northwest of David Lake).
bulrush, common great - *Scirpus validus*
bulrush, great - *Scirpus acutus*
bulrush, small-fruited - *Scirpus microcarpus*
bulrush, three-square - *Scirpus pungens*
bulrush, tufted - *Scirpus cespitosus*
bunchberry - *Cornus canadensis*
bur-reed - *Sparganium sp.*
bur-reed, slender - *Sparganium minimum*
buttercup, celery-leaved - *Ranunculus sceleratus*
buttercup, seaside - *Ranunculus cymbalaria*
buttercup, heart-leaved - *Ranunculus cardiophyllus*
buttercup, prairie - *Ranunculus rhomboideus*
butterwort, common - *Pinguicula vulgaris*

camas, white - *Zigadenus elegans*
candelabra, northern fairy - *Androsace septentrionalis*
cattail, common - *Typha latifolia*
chamaerhodos - *Chamaerhodos erecta*
cherry, choke - *Prunus virginiana*
cherry, pin - *Prunus pensylvanica*
chickweed, long-stalked - *Stellaria longipes*
chickweed, long-stalked mouse-ear - *Cerastium nutans*
chickweed, fielf mouse-ear - *Cerastium arvense*
cicely, blunt-fruited sweet - *Osmorhiza depauperata*
cinquefoil, marsh - *Potentilla palustris*
cinquefoil, prairie - *Potentilla pensylvanica* *
cinquefoil, rough - *Potentilla norvegica* *
cinquefoil, woolly - *Potentilla hippiana*
clover, alsike - *Trifolium hybridum* *
clover, white - *Trifolium repens* *
collomia, narrow-leaved - *Collomia linearis* *
coltsfoot, palmate-leaved - *Petasites palmatus*
coralroot, spotted - *Corallorhiza maculata*
corydalis, golden - *Corydalis aurea*
cotton grass, russett - *Eriophorum chamissonis*
cotton grass, thin-leaved - *Eriophorum viridi-carinatum*

cotton grass, tall - *Eriophorum polystachion*
cranberry, high-bush - *Viburnum opulus*
cranberry, low-bush - *Viburnum edule*
cress, bitter - *Cardamine pensylvanica*
cress, purple rock - *Arabis divaricarpa*
cress, reflexed rock - *Arabis holboellii*
crocus, prairie - *Anemone patens*
crowfoot, firm white water - *Ranunculus circinatus*
crowfoot, yellow water - *Ranunculus gmelinii*
cryptanthe, Fendler's - *Cryptantha fendleri*
currant, wild black - *Ribes americanum*

dandelion, common - *Taraxacum officinale*
dandelion, yellow false - *Agoseris glauca*
dewberry - *Rubus pubescens*
dock, western - *Rumex occidentalis* *
dragonhead, American - *Dracocephalum parviflorum* *
dropseed, sand - *Sporobolus cryptandrus*
duckweed - *Lemna sp.*
duckweed, common - *Lemna minor*

elephant's-head - *Pedicularis groenlandica*
everlasting, small-leaved - *Antennaria parvifolia*
everlasting, showy - *Antennaria pulcherrima*

fairybells - *Disporum trachycarpum*
fescue, rough - *Festuca scabrella*
fescue, Rocky Mountain - *Festuca saximontana*
fleabane, Philadelphia - *Erigeron philadelphicus*
fleabane, hairy - *Erigeron pumilus*
fleabane, smooth - *Erigeron glabellus* *
fleabane, tufted - *Erigeron caespitosus*
flixweed - *Descurainia sophia*
foxtail, short-awned - *Alopecurus aequalis* *

gaillardia - *Gaillardia aristata* *
gentian, fringed - *Gentianella crinita*
gentian, moss - *Gentiana prostrata*
geranium, wild white - *Geranium richardsonii*
goat'sbeard, common - *Tragopogon dubius*
goldenrod, Canada - *Solidago canadensis* *
goldenrod, low - *Solidago missouriensis* *
goldenrod, mountain - *Solidago spathulata* *
goldenrod showy - *Solidago nemoralis* *
gooseberry, northern - *Ribes oxyacanthoides*

gooseberry, wild - *Ribes hirtellum*
goosefoot, spear-leaved - *Monolepis nuttalliana*
grass, bearded wheat - *Agropyron trachycaulum var. unilaterale*
grass, common blue-eyed - *Sisyrinchium montanum*
grass, California oat - *Danthonia californica*
grass, crested wheat - *Agropyron pectiniforme* *
grass, rough hair - *Agrostis scabra* *
grass, Hooker's oat - *Helictotrichon hookeri*
grass, Indian rice - *Oryzopsis hymenoides*
grass, June - *Koeleria macrantha*
grass, manna - *Glyceria sp.*
grass, marsh reed - *Calamagrostis canadensis*
grass, northern reed - *Calamagrostis inexpansa*
grass, western porcupine - *Stipa curtiseta*
grass, purple oat - *Schizachne purpurascens*
grass, reed canary - *Phalaris arundinacea*
grass, sand - *Calamovilfa longifolia*
grass, salt - *Distichlis stricta*
grass, Nuttall's salt-meadow - *Puccinellia nuttalliana*
grass, sweet - *Hierochloe odorata*
grass, common tall manna - *Glyceria grandis* *
grass, tufted hair - *Deschampsia cespitosa*
grass-of-Parnassus, northern - *Parnassia palustris*
groundsel, balsam - *Senecio pauperculus*
groundsel, prairie - *Senecio canus*

harebell - *Campanula rotundifolia*
hawk's-beard, annual - *Crepis tectorum* *
hazelnut, beaked - *Corylus cornuta*
heal-all - *Prunella vulgaris*
heather, sand - *Hudsonia tomentosa*
hedge-nettle, marsh - *Stachys palustris*
honeysuckle, twining - *Lonicera dioica*
hornwort, - *Ceratophyllum demersum*
horsetail, common - *Equisetum arvense*
horsetail, meadow - *Equisetum pratense*
horsetail, swamp - *Equisetum fluviatile*
horsetail, variegated - *Equisetum variegatum*

ivy, poison - *Rhus radicans*

juniper - *Juniperus sp.*
juniper, creeping - *Juniperus horizontalis*
juniper, ground - *Juniperus communis* *

knotweed, common - *Polygonum arenastrum* *

ladies'-tresses, hooded - *Spiranthes romanzoffiana* *
lady's-slipper, yellow - *Cypripedium calceolus*
lamb's-quarters - *Chenopodium album* *
lichen, reindeer - *Cladina spp.*
lichen, reindeer - *Cladina mitis*
lily, western wood - *Lilium philadelphicum*
lily-of-the-valley, wild - *Maianthemum canadense*
lobelia, Kalm's - *Lobelia kalmii*
locoweed, early yellow - *Oxytropis sericea*
locoweed, late yellow - *Oxytropis monticola*
loosestrife, fringed - *Lysimachia ciliata* *
loosestrife, tufted - *Lysimachia thyrsiflora*

mare's-tail, common - *Hippuris vulgaris*
meadow-rue, veiny - *Thalictrum venulosum*
meadowsweet, narrow-leaved - *Spiraea alba*
milk vetch, purple - *Astragalus dasyglottis*
milkweed, low - *Asclepias ovalifolia*
milkwort, sea - *Glaux maritima*
mint, wild - *Mentha arvensis*
mosses, brown - *Drepanocladus sp.*
mosses, golden - *Tomenthypnum sp.*
mosses, peat - *Sphagnum sp.*
muhly, bog - *Muhlenbergia glomerata*
muhly, mat - *Muhlenbergia richardsonis*
mustard, green tansy - *Descurainia pinnata*
mustard, grey tansy - *Descurainia richardsonii*

nettle, common - *Urtica dioica*
nut-grass, sand - *Cyperus schweinitzii*

orchid, northern green bog - *Habenaria hyperborea*
orchid, round-leaved - *Orchis rotundifolia*
osier, red-osier - *Cornus stolonifera*

parsnip, water - *Sium suave*
peavine, purple - *Lathyrus venosus*
pepper-grass, common - *Lepidium densiflorum* *
pigweed, Russian - *Axyris amaranthoides*
plantain, common - *Plantago major*
persicaria, pale - *Polygonum lapathifolium* *
pondweed, - *Potamogeton sp.*
pondweed, flat-stemmed - *Potamogeton zosteriformis*

poplar, balsam - *Populus balsamifera*
prickly-pear, brittle - *Opuntia fragilis*
primrose, mealy - *Primula incana*
psoralea, silverleaf -*Psoralea argophylla*
puccoon, narrow-leaved - *Lithospermum incisum*

ragwort, marsh - *Senecio congestus*
ragwort, rayless - *Senecio indecorus*
raspberry, wild red - *Rubus idaeus*
rocket, prairie - *Erysimum asperum*
rocket, small-flowered - *Erysimum inconspicuum*
rose, wild common - *Rosa woodsii*
rose, prickly - *Rosa acicularis*
rush, toad - *Juncus bufonius* *
rush, wire - *Juncus balticus*
rye, Canada wild - *Elymus canadensis*

sage wort, pasture - *Artemisia frigida*
sage wort, prairie - *Artemisia ludoviciana*
saline shooting-star - *Dodecatheon pulchellum*
samphire - *Salicornia europea*
sandwort, blunt-leaved - *Moehringia lateriflora*
sarsaparilla, wild - *Aralia nudicaulis*
saskatoon - *Amelanchier alnifolia*
sea-blite, western - *Suaeda calceoliformis*
sedge - *Carex sp.*
sedge, awl-fruited - *Carex stipata*
sedge, beaked - *Carex rostrata*
sedge, bristle-stalked - *Carex leptalea*
sedge, brownish - *Carex brunnescens*
sedge, Crawe's - *Carex crawei*
sedge, Crawford's - *Carex crawfordii*
sedge, Douglas -*Carex douglasii*
sedge, golden - *Carex aurea*
sedge, graceful - *Carex praegracilis*
sedge, short - *Carex curta*
sedge, hair-like - *Carex capillaris*
sedge, sand - *Carex houghtoniana*
sedge, inland - *Carex interior*
sedge, two-stamened - *Carex diandra*
sedge, low - *Carex stenophylla*
sedge, northern bog - *Carex gynocrates* *
sedge, livid - *Carex livida*
sedge, thin-flowered - *Carex tenuiflora*
sedge, Parry's - *Carex parryana*

sedge, prairie - *Carex prairea*
sedge, Sartwell's - *Carex sartwellii*
sedge, sheathed - *Carex vaginata*
sedge, mud - *Carex limosa*
sedge, hay - *Carex siccata*
sedge, rush-like - *Carex scirpoidea*
sedge, hairy-fruited - *Carex lasiocarpa*
sedge, two-seeded - *Carex disperma*
sedge, Sprengel's - *Carex sprengelii*
sedge, sun-loving - *Carex pensylvanica*
sedge, thread-leaved - *Carex filifolia*
sedge, water - *Carex aquatilis*
sedge, woolly - *Carex lanuginosa*
selaginella, prairie - *Selaginella densa*
shepherd's-purse - *Capsella bursa-pastoris*
silverberry - *Elaeagnus commutata*
silverweed - *Potentilla anserina*
skeletonweed - *Lygodesmia juncea*
skeletonweed, annual - *Lygodesmia rostrata*
skullcap, marsh - *Scutellaria galericulata*
snakeroot - *Sanicula marilandica*
snowberry - *Symphoricarpos albus*
Solomon's-seal, star-flowered - *Smilacina stellata*
Solomon's-seal, three-leaved - *Smilacina trifolia*
sow-thistle, smooth perennial - *Sonchus uliginosus* *
spike-rush, - *Eleocharis sp.*
spike-rush, creeping - *Eleocharis palustris*
spike-rush, few-flowered - *Eleocharis quinqueflora*
spike-rush, flattened - *Eleocharis compressa*
stinkweed - *Thlaspi arvense*
strawberry, wild - *Fragaria virginiana*
sundew - *Drosera sp.*
sundew, oblong-leaved - *Drosera anglica*
sundew, slender-leaved - *Drosera linearis*
sunflower, rhombic-leaved - *Helianthus subrhomboideus* *

thistle, Canada - *Cirsium arvense* *
thistle, Flodman's - *Cirsium flodmanii*
thistle, Drummond's - *Cirsium drummondii*
toadflax, bastard - *Comandra umbellata*
twinflower - *Linnaea borealis*

umbrellawort, hairy - *Mirabilis hirsuta*

vetch, wild - *Vicia americana*

vetchling, cream-colored - *Lathyrus ochroleucus*
violet, bog - *Viola nephrophylla*
violet, early blue - *Viola adunca*
violet, western Canada - *Viola canadensis*
violet, yellow prairie - *Viola nuttallii*

water-hemlock - *Cicuta maculata* *
water-hemlock, bulb-bearing - *Cicuta bulbifera*
water-horehound, American - *Lycopus americanus*
water-milfoil, speked - *Myriophyllum exalbescens*
water-plantain, broad-leaved - *Alisma plantago-aquatica*
whitlow-grass, annual - *Draba nemorosa*
wigeon-grass - *Ruppia maritima*
willow - *Salix sp.*
willow, autumn - *Salix serissima*
willow, basket - *Salix petiolaris*
willow, beaked - *Salix bebbiana*
willow, myrtle-leaved - *Salix myrtillifolia*
willow, bog - *Salix pedicellaris*
willow, false mountain - *Salix pseudomonticola*
willow, hoary - *Salix candida*
willow, velvet-fruited - *Salix maccalliana*
willow, pussy - *Salix discolor*
willow, sandbar - *Salix exigua*
willow, shining - *Salix lucida*
willow, flat-leaved - *Salix planifolia*
willowherb, northern - *Epilobium ciliatum*
willowherb, narrow-leaved - *Epilobium leptophyllum*
wintergreen, one-sided - *Orthilia secunda* *
wintergreen, common pink - *Pyrola asarifolia*
wood-rush, field - *Luzula multiflora*
wormwood, plains - *Artemisia campestris*

yarrow, common - *Achillea millefolium*

BRYOPHYTES OF THE WAINWRIGHT DUNES ECOLOGICAL RESERVE

(Based on July 29, 1992 fieldtrip by J. Derek Johnson)

Aulacomnium palustre
Brachythecium salebrosum
Brachythecium turgidum
Bryum pseudotriquetrum
Ceratodon purpureus

Dicranum undulatum
Drepanocladus aduncus
Drepanocladus vernicosus
Eurhynchium pulchellum
Helodium blandowii
Hylocomium splendens
Marchantia polymorpha
Plagiomnium ellipticum
Pohlia nutans
Polytrichum strictum
Pylaisiella polyantha
Tomenthypnum nitens

LICHENS OF THE WAINWRIGHT DUNES ECOLOGICAL RESERVE

(Based on a July 29, 1992 fieldtrip by J. Derek Johnson)

Cetraria ericetorum
Cladina mitis
Evernia mesomorpha
Melanelia septentrionalis
Parmelia sulcata
Peltigera didactyla
Peltigera polydactyla
Physcia aipolia

APPENDIX 9

WAINWRIGHT DUNES ECOLOGICAL RESERVE

VEGETATION CHANGE/DISTURBANCE ASSESSMENT

(NOTE: This Appendix contains only the summary of the report completed by Pearsen Timberline Forestry Consultants, 1993)

WAINWRIGHT DUNES ECOLOGICAL RESERVE
VEGETATION CHANGE/DISTURBANCE ASSESSMENT

Prepared For:

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April 1993

EXECUTIVE SUMMARY

The Wainwright dunes area was established as an Ecological Reserve in 1988 representing the native ecosystems of the Central Subregion of the Parkland Natural Region. The Wainwright Dunes Ecological Reserve is characterized by aspen groves interspersed with grassland, aeolian landforms and associated vegetation, interdune fen complexes, a variety of wetland types, kame and disintegration moraine.

To provide direction for management of the reserve the Wainwright Dunes Ecological Reserve Management Plan is being developed. A high priority has been placed on obtaining information needed for monitoring and managing the reserve including an inventory of the current vegetation and cover type change and/or disturbances over the past three decades.

This report describes the methodology and results of a project initiated September, 1992 to identify and map, at a scale of 1:10,000, vegetation cover types and disturbances and to determine the changes that have occurred in the vegetation cover from 1963 to 1990. Specific objectives included:

1) To identify, inventory and map present (1990) vegetation cover and disturbances at 1:10,000 using current Alberta Vegetation Inventory (AVI) specifications and 1:5,000 colour infrared (CIR) photographs.

2) To identify, inventory and map 1963 vegetation cover types and disturbances at 1:10,000 using AVI specifications and 1:31,680 black and white aerial photographs.

3) To determine the location and extent of change from 1963 to 1990 in tree cover (aspen, poplar).

4) To determine the location and extent of shrub encroachment, particularly within the sand dune and parkland areas of the Ecological Reserve.

5) To prepare a summary report which provides an overview description of the area, which details the area covered by each vegetation cover type and disturbance, and which documents any vegetation or disturbance trends detected.

A photo interpretive inventory using Alberta Vegetation Inventory (AVI) specifications and standards was undertaken within the reserve October 1992. Two separate AVI classifications were done for 1963 and 1992 using 1963 1:31,680 black and white aerial photography and 1990 1:5,000 colour infrared aerial photographs respectively. A ground reconnaissance selected thirty-four AVI, site, and vegetation (shrubs only) sample data sets distributed throughout the reserve within representative strata. Shrub cover codes, shrub distribution codes and shrub species codes were also recorded for all grassland and shrubland cover types. Once classification was completed, cover type polygons were transferred onto 1:10,000 scale orthophotos, assigned a unique polygon number and digitally loaded using ARC INFO GIS software and linked to a corresponding cover type attribute database.

Final map products include:

1) 1:10,000 mylar 1963 AVI inventory (hard copy and digital)
2) 1:10,000 mylar 1992 AVI inventory (hard copy and digital)
3) 1:10,000 mylar cover type change (digital)

Eight broad cover types are identified for the current inventory with area summaries presented in Table 1. Forest, shrubland and grassland have been further divided on the basis of moisture regime. A description of each cover type is summarized in Table 2.

Age cores obtained from the sample sites indicate the following general trends:

1) Ages ranged from 19 to 95 years old with the oldest stands occurring in the southwest portions of the reserve and the youngest as stunted clumps or individuals throughout the grassland, and along the edges of treed areas.

2) Stands taller than 7 meters were primarily established between 1910 and 1945.

3) Stands shorter than or equal to 7 meters were primarily established between 1955 and 1973 (the majority between 1955 and 1965).

4) The majority of stands were established within the 1930 (1930 - 1939) and 1950 (1950 - 1959) origin classes.

5) Very little evidence of aspen or balsam poplar stands younger than 19 years old were found suggesting that deciduous tree expansion occurred periodically, taking advantage of periods of higher moisture following periods of drought.

6) Stands older than 55 years contain a high degree of stain or rot. Moisture deficits and slower growth have been equated with more defect in aspen (Peterson and Peterson, 1992).

Signs of tree mortality are evident throughout the reserve, probably a result of disease and insects. Insect defoliation has been observed to be a fairly regular occurrence over the past few years.

The change analysis for the period between 1963 and 1990 is summarized in Table 3. General trends are as follows:

1) Tree cover increased by 59 percent for an annual rate of 2.2 percent.
2) Grassland decreased by 26 percent for an annual rate of 1.0 percent.
3) Scrub forest decreased by 54 percent for an annual rate of 2.0 percent.
4) Shrubland increased by 34 percent for an annual rate of 1.3 percent.
5) Sand increased by 33 percent.
6) Fens decreased by 12 percent.
7) Water increased by 225 percent.
8) Anthropogenic was not present in 1963.

These figures represent the percent change by cover group and should be assessed in reference to the actual hectares involved (Table 3). The annual encroachment figures are misleading as tree and shrub expansion is usually periodic as a result of bioclimatic occurrences. Age samples indicate that major aspen expansion ceased in the early 1970's.

The results of the study indicate an increase in forest and shrub cover with a corresponding decrease in grassland. Comparisons with previous studies support these conclusions. Approximately 35 percent of the increase in tree cover is a result of the change of scrub forest to forest cover with the remaining increase attributable to aspen expansion between 1957 and 1967. Approximately 15 percent of the decrease in grassland can be attributed to mesic/dry shrub encroachment with the remainder to aspen expansion. The interpretation of actual figures should be read with some caution as the differences between the 1963 (1:31,680) and 1990 (1:5,000) photo scales and quality were large.

A cursory study of 1935 to 1985 weather station data from Hughenden seems to verify the conclusion of previous studies that aspen expansion usually occurs when soil temperature and moisture conditions within the month of June are favourable, particularly following periods of drought.

For future monitoring studies photo scales should match the 1:5,000 1990 photographs. The cover type change map will provide a good basis for determination of sites for monitoring of future encroachment. Ground plots or transects and aerial monitoring techniques can be employed across the various boundaries of change or within specific polygons, particularly grassland cover types.

Review of the literature suggests that prescribed fire and grazing are viable management strategies for reclamation of aspen or shrub encroachment in grassland. Candidate cover types include all scrub forest and low B density (31 to 41 percent crown closure) dry or mesic forest with a continuous cover of fine (grass) and medium to coarse (shrub, downfall) understory fuels. Dry and mesic shrub cover types are also responsive to treatment, however buckbrush areas may require chemical treatment.

TABLE 1 WAINWRIGHT DUNES COVERTYPE AREA SUMMARY (1990)

COVERTYPE		AREA	
		Ha	%
FOREST	Mesic/Wet	410	14
	Dry	934	32
	Sub Total	1344	46
SCRUB FOREST		149	5
SHRUBLAND	Wet	144	5
	Mesic/Dry	90	3
	Sub Total	234	8
GRASSLAND	Wet	102	4
	Mesic	64	2
	Dry	955	32
	Sub Total	1121	38
SAND		8	0
FENS		96	3
WATER		13	0
ANTHROPOGENIC		5	0
TOTAL		2970	100

TABLE 2 WAINWRIGHT DUNES VEGETATION COVER TYPE DESCRIPTION SUMMARY

VEGETATION COVER TYPE		SURFACE DEPOSIT AND LANDFORM	SOILS	MOISTURE REGIME/ DRAINAGE	SLOPE PRECENT	ASPECT	DOMINANT SHRUBS (Trees if present)	DOMINANT FORBES (Bryophytes)	DOMINANT GRASS (Lichens)
FOREST	Wet	Depressional Aeolian	Gleyed Dark Brown Chernozem GleyedDark Grey Chernozem Gleyed	Subhygric to hygric Imperfect	0 - 5	All	Populus balsamifera Populus tremuloides Cornus stolonifera Rosa acicularis Viburnum edule	Aralia nudicaulis Thalictrum vesculosum Aster ciliolatus	
	Mesic	Sandy Outwash Plain Lacustrine (David Lake) Dune (lee side)	Orthic Dark Brown Chernozem Orthic Regosol	submesic to mesic well to moderate	0 - 5 35 - 70	All N, NE	Populus tremuloides Prunus virginiana Amelanchier alnifolia Rosa acicularis	Galium boreale Lathyrus ochroleucus Pyrola arifolia	
	Dry	Interdune Depressions Sandy Outwash Plain Dune Complex Kame Disintigration Moraine	Orthic Regosol	Xeric to subxeric well to rapid	variable	All (usually absent from SW slopes)	Populus tremuloides Rosa acicularis Juniperus horizontalis Arctostaphylos uva-ursi	Galium boreale	Festuca spp Carex foerica
SCRUB FOREST		Aeolian Outwash plain Dune	Orthic Regosol	xeric to subxeric well to rapid	variable	All	Populus tremuloides Juniperus horizontalis Rosa spp Arctostaphylos uva-ursi	Spirea alba Yellow peavine Galium boreale	Festuca spp Carex spp Lichens
SHRUBLAND	Wet	Depressional Aeolian Lacustrine	Rego Gleysols (some calcareous)	Subhydric poor to imperfect	0 - 5	All	Salix spp Cornus stolonifera	Galium triflorum	Carex spp
	Dry/Mesic	Sandy Outwash plain Lacustrine Dune	Orthic Regosol	submesic to mesic rapid to well	variable	All	Symphoricarpos occidentalis Eleagnus commutata Rosa spp	Yarrow Prairie sage Smooth Aster	Bearded wheat grass June grass Graceful sedge
GRASSLAND	Wet	Depressional Aeolian Lacustrine	Rego Gleysols (some calcareous) (saline near David Lake)	subhygric to subhydric poor	0	All	Salix spp	Potentilla anserina	Carex spp Calamagrostis inexpaisa Poa pratensis
	Mesic	Sandy Outwash Plain Lacustrine	Dark Brown Chernozem Humic Gleysol (calcareous)	submesic to mesic well to moderate	0 - 10	All	Symphoricarpos occidentalis Eleagnus commutata Rosa spp	Antennaria nitida Selaginella densa	Festuca scabrella Carex spp Stipa spartea
	Dry	Aeolian Outwash Plain/Dune Complex Kame Disintigration Moraine	Orthic Regosol	xeric to submesic rapid	variable	All	Juniperus horizontalis Rosa spp Prunus virginiana	Selaginella densa	Calamovilfa longifolia Artemisia frigida Festuca scabrella Lichens
FEN		Depressional Aeolian	Organic Fibrisol, Mesisol Mesisol	subhydric to hydric Poor to very poor	0 (sloping fen 10-35)	All	Betula pumila Salix spp	Potentilla palsuris Tomenthypnum nitins Drepanocladus spp	Carex spp Calamagrostis inexpensa
SAND		Aeolian Dune Undulating Outwash	Regosols	very xeric to xeric rapid	5 - 30	S, SW	Populus tremuloides Juniperus horizontalis Prunus virginiana	Selaginella densa	Carex foerica Calamovilfa longifolia Elymus canadensis

TABLE 3 WAINWRIGHT DUNES COVERTYPE CHANGE 1963 - 1990

COVERTYPE		HECTARES 1963	HECTARES 1990	PERCENT COVER 1963	PERCENT COVER 1990	CHANGE +/- ha	CHANGE %	CHANGE % OF TOTAL AREA
FOREST	Mesic/Wet	422	410	14	14	-12	-3	0
	Dry	420	934	14	32	+514	122	17
	Sub Total	844	1344	28	46	+500	59	17
SCRUB FOREST		324	149	11	5	-175	-54	6
SHRUBLAND	Wet	142	144	5	5	+2	0	0
	Mesic/Dry	32	90	1	3	+58	181	2
	Sub Total	174	234	6	8	+60	34	2
GRASSLAND	Wet	122	102	4	4	-20	-16	1
	Mesic	48	64	2	2	+16	33	1
	Dry	1341	955	45	32	-386	-29	13
	Sub Total	1511	1121	51	38	-390	-26	13
SAND		6	8	0	0	+2	33	0
FENS		109	96	4	3	-13	-12	0
WATER		4	13	0	0	+9	225	0
ANTHROPOGENIC		0	5	0	0	+5	-	0
TOTAL		2970	2970	100	100			

APPENDIX 10

GLOSSARY OF TERMS USED IN DRAFT MANAGEMENT PLAN

A GLOSSARY OF TERMS USED IN THE WAINWRIGHT DUNES ECOLOGICAL RESERVE MANAGEMENT PLAN

Ecological Terms:

Biological diversity - the distribution of different plants and animals communities within an area.

Climax - The final or stable biotic community in a successional series which is self-perpetuating and in dynamic equilibrium with the physical habitat, i.e. the assumed end point in succession.

Ecology - environmental biology, ie. the relation of organisms or groups of organisms to their environment.

Ecoregion - an area characterized by a distinctive regional climate expressed by vegetation.

Ecosystem - is the basic functional unit in ecology and includes both abiotic environment and biotic communities each influencing the properties of the other and both necessary for maintenance of life.

Ecotourism - a type of tourism which is directed towards the recreation use of ecosystems.

Ecotypic - a locally adapted population within a species which has certain genetically determined characteristics.

Land Form and Soils:

Blowouts - open sand depressions produced by wind.

Chernozem - a soil developed under grassland conditions, characterized by a black and organically rich top soil.

Geomorphic - having to do with the shape or the surface features of the earth.

Gleysol - a soil developed under conditions of prolonged periods of saturation with water.

Kame moraine - an irregular ridge or hill of stratified glacial drift.

Quaternary resources - period that includes the Pleistocene and Recent.

Regosol - a soil developed without definite genetic horizons and developing from or on deep unconsolidated, soft mineral deposits such as sands, loess, or glacial drift.

Types of Species and Vulnerability:

Exotic species - an organism or species which is not native to the region in which it is found.

Extirpation - extinction of a species from an area.

Fauna - animals

Introduced species (Non-indigenous species) - a species not belonging to the original species found in the area.

Native species - a species belonging to the original species found in the area.

Grazing Terms:

Animal Unit Month - is the forage required to support the equivalent of one 1000-lb. cow with an unweaned calf at her side for one month. For the purposes of this management plan, a yearling shall require the same amount of forage per month as one cow-calf pair. Cows larger than 1000-lb. require increased forage consumption and stock numbers shall be reduced accordingly.

Aspen encroachment - the ecological process where aspen plants increase into grasslands and other openings.

Carryover - vegetation which has not been grazed and allowed to decompose and become part of the soil surface the following year.

Grazing capacity - the total number of animals which may be sustained on a given area based on the total forage resources available.

Rotational grazing - a grazing system where animals are moved from one grazing unit to another and specific grazing units are rested for plant rest, regrowth and reproduction.

Range Condition (Ecological Condition) - the present state of vegetation of a range site in relation to the climax (natural potential) plant community for that site. It is an expression of the relative degree to which the kinds, proportions, and amounts of plants in a plant community resemble that of the climax plant community for the site.

Boreal forest - an ecological area of the province that includes coniferous, deciduous, and peatland vegetation ie. mixtures of aspen, balsam poplar, spruce and birch.

Fen - peatlands characterized by a high water table, nutrient rich, and pH 5.5 to 7.0. Vegetation can be combinations of grass, shrubs, and trees.

Flark - water filled depressions in a fen system.

Flora - plants.

Forb - broad leaved plants, i.e. dandelion.

Strings - raised ridges in a fen system.

Miscellaneous:

Benchmarks - it is a permanent reference point used to measure changes in

vegetation through time.

Landform - any element of the landscape characterized by a distinctive surface expression, and internal structures, i.e. knob and kettle landform.

Outwash deposit - is a deposit laid down under fluvioglacial conditions around the margin of an ice sheet or beyond the snout of a glacier, fed by the subglacial streams.

Outwash Plain - includes the alluvial plain formed by the streams originating from the melting ice of a glacier, which carry away some of the material of the moraine, and deposit it over a considerable areas (the coarser material is deposited near to the ice, the finer material farther away).

Saline meadow - grassland areas that have salt concentrations in the soil due to high water content.

Subclimax - a state of plant succession that remains relatively fixed and unable to reach climax, ie. aspen poplar is often a subclimax species on white spruce sites.

Succession - the progressive replacement of plant communities on a site which leads to the potential and stable natural plant community.

Wildlife - includes both plant and animal species.

APPENDIX 11

SURFACE AND GROUNDWATER SYSTEMS

APPENDIX 11

Surface and Groundwater Systems

a) Watershed and Runoff

Due to the sandy terrain, the surface and shallow groundwater systems are closely related to each other. Apart from a small area in the northwest which drains towards Wallaby Lake, most of the Reserve is contained in watersheds which drain to David Lake or to wetlands south of David Lake. Small areas of these watersheds extend outside the Reserve, on the west side into farmland, and on the north side into Camp Wainwright. A larger area of about 11 km^2 extends east of the Reserve into Farmland. Figure 1.

The mean annual surface water runoff for the Ecological Reserve area is estimated to be equivalent to 20 mm annually. Mean annual precipitation is estimated at 417 mm, and mean annual evaporation at 698 mm. It is estimated that on average only about 57% of the 36 km^2 watershed contributes runoff to David Lake. This is consistent with the many interdunal depressional areas in the Reserve (Hydrology Branch, 1993). Surface outflow from David Lake would only occur during periods of high lake levels and runoff. The outflow would be southward through other lakes and marshes to Black Creek, and thence to Ribstone Creek and the Battle River.

b) Groundwater

The Reserve and surrounding land is a recharge area for a shallow groundwater flow system which is separated from deep aquifers by underlying clay or till. The recharge for this shallow system is supplied mainly from rainfall and snowmelt. The flow system feeds the streams, smaller water bodies and fens of the Reserve as well as David Lake and the wetlands south of David Lake. The water table is generally an extension of surface water levels in the Reserve. Currently there are no significant groundwater users in the area surrounding the Reserve. The few existing wells are tapping deep aquifers that would not affect the shallow groundwater flow system (Hydrogeology Branch, 1993).

c) David Lake

From aerial photographs and local sources, it is known that David Lake water levels have varied considerably in the past, with a recent long decline occurring since 1981. The lake was dry in the fall of 1992, and in May 1993 it was probably less than a foot deep (Loonen, Public Lands, 1993). In the shallow basin, small water level changes can cause significant changes in the lake's surface area. At its present low level, the lake is surrounded by a wide margin of wet meadow.

As a receiving body for both surface and groundwater, David Lake can be considered an integral component of the local ecosystem and a crude indicator of water supply and quality in the Reserve and the watershed. Developments in areas outside the Reserve as well as the uses inside it could affect the quantity and quality of water in David Lake and in the ponds, fens, springs, and streams draining to it.

d) Water Management Activities

Ducks Unlimited undertook waterfowl habitat enhancement on David Lake in 1990. This work consists of 15 rock islands for nesting sites and three non-draining level ditches. The ditches are designed to provide open water for duck nesting territories in areas of dense emergent vegetation. At present the ditches are outside the main water body, but at the long term average water level they would be within the main water body providing open channels through the dense vegetation (see air photograph). A new stockwatering dugout was excavated in the winter of 1992/93, physically adjoining the most westerly of the DU level ditches. The ditches and dugout are deep enough to tap into the groundwater. The spoil piles along the ditches and the dugout are noticeable and detract from the natural appearance of this part of the Reserve.

There are no licensed surface or groundwater users in the Reserve or in the David Lake watershed. There may be some unlicensed domestic wells in farmland adjacent to the Reserve. The David Lake DU level ditches were built on a permit issued by WRAD Regional Services, and the recently constructed dugout was approved by Public Lands.

There is a spring north of David Lake in NE 2-42-5-W4 which has been distrubed at its source by cattle.

APPENDIX 12

WAINWRIGHT DUNES ECOLOGICAL RESERVE BENCHMARK

METHODOLOGY FOR THE SAND DUNE AREA AND 1993 DATA COLLECTION RESULTS

Dave Downing and Russ Wells
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of Environmental Protection

TERMS OF REFERENCE
WAINWRIGHT DUNES ECOLOGICAL RESERVE
BENCHMARK SITE MONITORING

1. INTRODUCTION

1.1 Background

The Wainwright Dunes Management Plan requires that grazing management within and adjacent to the Ecological Reserve be planned and conducted to maintain ecosystems in a natural condition. The stated objectives of grazing management include, in part:

1. The definition of grazing levels appropriate to maintaining healthy (native) range ecosystems;
2. The application of ecological principles to range management; and
3. The development and implementation of range monitoring to measure the impact of grazing and other influences on plant communities within the Reserve.

Further to the third objective, the Wainwright Dunes Management Plan states that a monitoring plan shall be established to evaluate impacts of cattle grazing. It further specifies that monitoring shall include the monitoring of plant species, habitats and range reference areas to compare plant community composition, and that the presence and abundance of both representative and rare species should also be monitored.

The Resource Information Division (Department of Environmental Protection) was requested to develop and implement a monitoring strategy to satisfy the requirements of this objective. The strategy focuses on the monitoring of cattle grazing influences within dune areas in the north half of the Ecological Reserve.

1.2 Purpose and Objectives

These Terms of Reference address the primary question of whether cattle grazing has caused a change in plant species composition in grazed areas versus ungrazed areas on dune landscapes within the Reserve. The initial goal of this monitoring plan is therefore to detect changes that may occur as a result of cattle grazing in the dunes area of the Reserve.

The basic strategy to detect such changes will be to establish a set of range reference areas, or benchmark sites, and document changes on these areas.

The objectives of these Terms of Reference are outlined below and are addressed more fully in subsequent sections of the document as indicated.

Introductory Section (below)

Define benchmark sites and delineate study area boundary.

Section 2: Main study hypothesis and experimental design

Set out the primary hypotheses that define data collection and analysis needs, and provide a design appropriate to hypothesis testing and data presentation. Discuss, in detail, the operational requirements of data collection.

Section 3: Data management and reporting

Propose methods for capturing, analyzing and reporting data collected from benchmark sites.

Section 4: Site establishment and protection

Provide guidelines for site establishment and protection

Section 5: Schedule

Provide a sampling schedule for re-sampling benchmark sites.

These objectives and the working hypotheses may change over time as the science of biomonitoring advances. One way of keeping track of such changes is to issue versions of these Terms of Reference when significant changes do occur, and to track such revisions in a Preface to the Terms.

1.3 Benchmark Site Definition

A benchmark site is any reference area that provides a resource manager with "information on the kinds and amounts of plant species present and the production potential of a specific range site or plant community" (Society of Range Management 1975). This definition implies that range sites and plant communities can be recognized and classified. Ehlert and Downing (1992) recognize two categories of benchmark sites:

1. Primary sites are characterized by vegetation and site conditions which are typical of widespread landscapes, such as ecoregions or natural regions.

2. Secondary sites represent uncommon, rare and/or fragile vegetation types and/or range sites.

The dune landscapes of the Ecological Reserve fall into the second category and are the focus of these Terms of Reference.

1.4 Location of Benchmark Sites

Within the Wainwright Dunes study area, all benchmark sites will be located within Twp 42 R. 5 W4M. Dune landscapes within Sections 9 and 16 are the 'control' sites, as these receive low or no cattle grazing pressure. Dune landscapes within Sections 11, 14 and 15 are the 'grazed' sites. The distinction between 'control' and 'grazed' sites is clarified in Section 2 of this Terms of Reference.

Map 1 shows the location of benchmark sites established in June 1993 according to these Terms of Reference.

2. MAIN STUDY HYPOTHESES AND EXPERIMENTAL DESIGN

2.1. Introduction

The scientific method is a fundamental concept guiding this or any other scientific investigation. It involves the development and testing of hypotheses to reach reliable conclusions about observable events. Hypotheses are general statements that predict the outcome of observable events, and hypothesis testing provides a focus for data collection and analysis. Clearly stated and testable hypotheses are basic to the process of experimental design which is "concerned with planning experiments in order to obtain the maximum amount of information from the available resources" (Milliken and Johnson 1984).

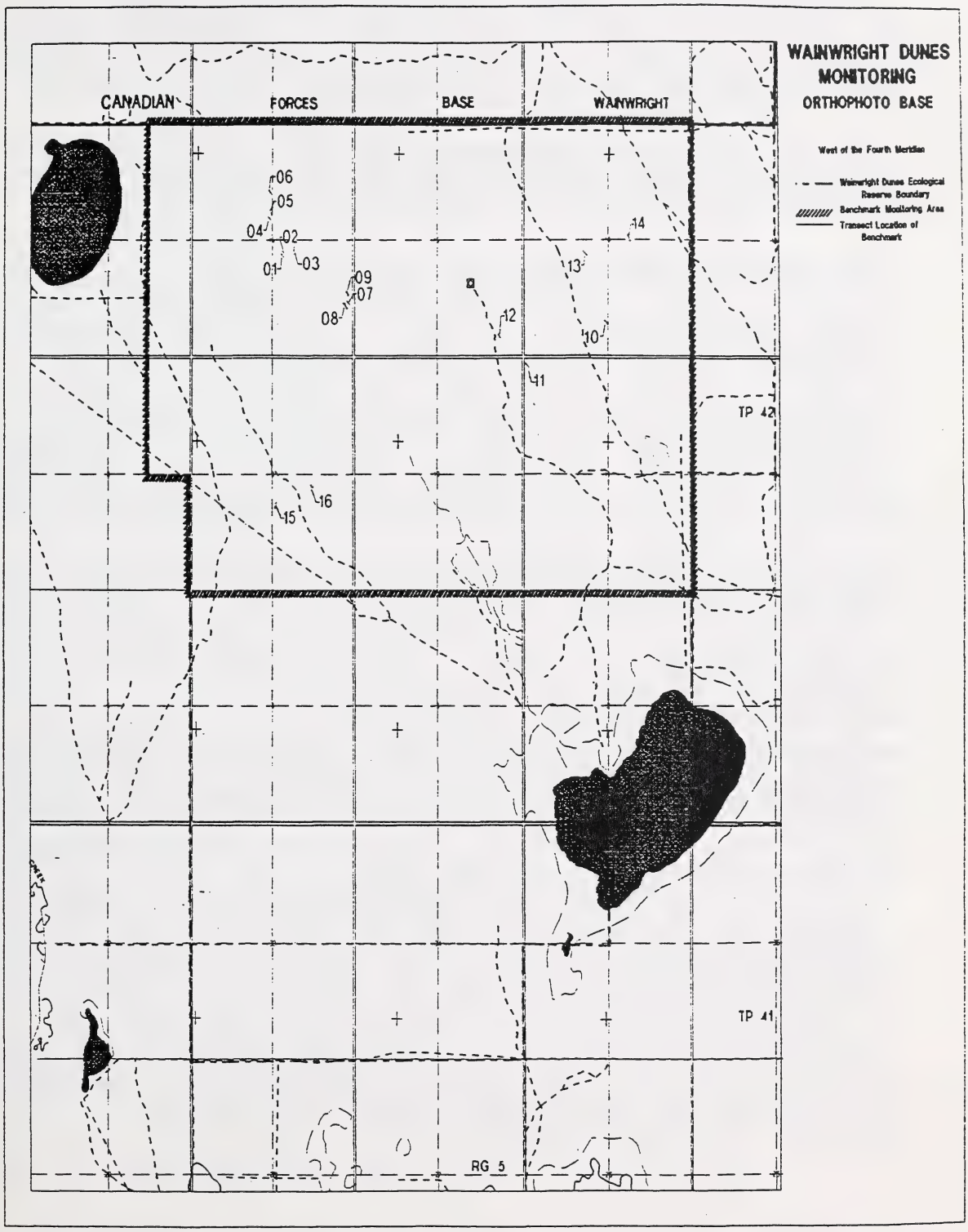
2.2 Hypotheses

Two categories of hypotheses pertain to investigations under these Terms of Reference:

1. Those hypotheses which have been repeatedly tested over time and are accepted as valid models; and

2. Those hypotheses which relate directly to the primary question of whether cattle grazing has caused significant change to dune landscapes, and particularly vegetation, within the Ecological Reserve. These hypotheses are termed working hypotheses.

Research in the field of vegetation ecology has resulted in a number of models that fall under the first category, and which provide a logical framework for testing working hypotheses. The functional model developed by Major(1951) provides an appropriate framework within which working hypotheses related to the primary question can be tested. Briefly, this model states that the vegetation of an area develops through the interaction, over time, of climate, organisms, relief and parent material.



MAP 1. Benchmark site locations within north half of Wainwright Dunes Ecological Reserve

The main working hypothesis to be tested is a re-statement of the primary question given in Section 1.2 - that is, does cattle grazing cause a difference in plant species composition within dune landscapes of the Reserve? It is presented in the conventional 'null' form as follows:

There is no difference in vegetation composition between sites that receive no or very low cattle grazing pressure and sites that receive a significant level of cattle grazing pressure.

Within the framework provided by the functional model, we see that in order to test this hypothesis, it is necessary to control or otherwise consider variation in a number of factors (climate, relief, parent material) in order to obtain any meaningful information on the effects of organisms (specifically, cattle). We can control variation in relief and parent material by choosing sampling locations in both grazed and ungrazed areas that are similar in terms of their slope, aspect, and soil characteristics. We can control the influence of humans and cattle through management practices that regulate use. We cannot control the influence of other organisms (e.g. insects, small mammals, ungulates) nor of climate, but we can employ sampling and analytic techniques that allow us to account for their influence.

The development and implementation of an experimental design that takes these factors into consideration was undertaken in 1993 and is detailed below.

2.3 Study Design

2.3.1 Site Selection

Representative sites for both grazed and ungrazed dune landscapes are located in the general areas given in Section 1.4. These areas are separated by a large wetland which acts as a natural barrier to cattle movement between the eastern grazed area to the western ungrazed area; both areas are fenced off from adjacent lands to the west, north and east. Grazing intensity in the western ungrazed area is low, as indicated by the presence of scattered, weathered cowpats and the absence of well-developed trails. Grazing intensity in the eastern grazed area is controlled through regulation of cattle numbers and turn-out dates, and appears (1993) to be moderate, as indicated by the presence of fresh cowpats and cattle trails.

A number of potential benchmark sites were evaluated over a ten-day period in June 1993; the evaluation and selection of benchmark sites employed the physiographic categories outlined by Fehr (1984, p. 24-27). These are as follows:

1. Active blowouts- saucer-shaped depressions formed by the

deflation of sand through a breach in the vegetation cover (David 1977) and showing signs of active erosion or deposition.

2. Stabilized blowouts- similar to active blowouts in that there has been recent erosion, but none is occurring at present.

3. Dune ridge- of the North Battleford type showing the characteristic dune form (David 1977) and showing few signs of erosion aside from some blowout hollows on the south sides.

4. Interdune depressions- depressions between two parallel dune ridges, no recent erosion.

5. Sand flats- level to undulating areas of aeolian sand deposits between areas of dune ridges, no recent erosion.

Of these five categories, only the sand flats and dune ridge categories were selected for consideration. The other categories are either not well represented in either the grazed or ungrazed areas (active and stabilized blowouts), are not likely to be utilized by cattle without encouragement (e.g. salting, herding), or are too variable to sample consistently.

The dune ridge features differed significantly between the eastern grazed areas and western ungrazed areas. Dunes to the east are characterized by short (<15m) moderate to strongly sloping faces and a north-northwest to south-southeast orientation. Dunes to the west are characterized by longer, strong to extreme slopes and a northwest to southeast orientation. Consequently, benchmark sites designed to compare grazed to ungrazed areas were not established on dune ridges. However, six sites were established on southwest and northeast facing dune slopes in the ungrazed area. Data from these sites will be useful in detecting vegetation change due to factors other than grazing on dune ridge sites. Criteria for selecting similar dune ridge sites based on site characteristics are given in Table 1.

Subtle variations in microtopography often result in significant vegetation changes on the sand flats. 'Low' areas less than a metre or so below the average microtopographic elevation are slightly moister, and often support willow or stunted aspen communities which contrast strongly with adjacent juniper-sedge/grass communities. Therefore, to establish ecologically similar benchmark sites, a number of criteria based on site characteristics had to be considered. These criteria include both microtopographic variations within the sand flats and the influence of adjacent dunes.

Table 1. Benchmark sites and selection criteria: dune ridges and sand flats

BENCHMARK SITE TYPE	SITE CHARACTERISTICS
Dune ridges: Dune grasslands (south-facing dune slopes)	Flat (to slightly concave or convex) slopes between 20-50% and >15m in length; dune faces with SW orientation, (orientation of long axis of dune between 90 and 210 degrees); rapidly drained very dry orthic regosols or orthic dark brown soils on sand.
Dune ridges: aspen stands (north-facing dune slopes)	As above, but dune faces have NE orientation and sites are moderately dry to moderately moist.
Sand flats	Microtopographic variations (minor slope changes) <2m; not immediately adjacent dunes (not unduly influenced by local snow deposition or groundwater patterns); slopes <10%; rapidly drained, dry orthic regosols or orthic dark brown soils (Edgerton or Wainwright series respectively) on sand; sand flats must be at least 30m wide (between dunes) and 50m in length.

A total of sixteen benchmark sites were established in June 1993; these are summarized by location and physiographic category in Table 2.[1] There are three sites in each of the dune grassland and dune aspen categories in the ungrazed area, and five sites on sand flats in both the grazed and ungrazed areas.

2.3.2 Data collection

A number of questions should be asked when data collection is in the planning stages:

1. What data are to be collected? What analytic techniques are to be applied, and what kind of data are needed for these techniques?

2. What is the basic sampling unit? How many replicates are required?

3. How often do sites have to be revisited? How will sampling units be relocated so that the same units can be resampled from one sampling period to the next?

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[1] A unique number is assigned to each benchmark site as a shorthand reference to location and site data.

Table 2. Benchmark site numbers and locations by physiographic category and grazing intensity (all within Twp. 42 R5 W4M)

Physiographic category and plot number	LSD-Section	Grazing intensity
Dune ridge: grasslands		
34WD001	07-16	ungrazed
34WD004	11-16	ungrazed
34WD008	01-16	ungrazed
Dune ridge: aspen grove		
34WD002	07-16	ungrazed
34WD005	11-16	ungrazed
34WD007	01-16	ungrazed
Sand flats		
34WD003	07-16	ungrazed
34WD006	11-16	ungrazed
34WD009	08-16	ungrazed
34WD010	03-14	grazed
34WD011	13-11	grazed
34WD012	01-15	grazed
34WD013	06-14	grazed
34WD014	10-14	grazed
34WD015	07-09	ungrazed
34WD016	08-09	ungrazed

4. How will site influences, other than those being studied, be controlled?

Mueggler (1992) addressed many of these questions in his investigation of climatically-induced vegetation change on mountain grasslands in Montana. He described problems in attempting to interpret the reasons for vegetation change over a twenty-year period, and concluded that short-term environmental variations before and at the time of sampling can have a significant effect on results. These variations included the influence of yearly weather differences (precipitation and temperature), time of sampling, and animal population cycles, all of which he termed confounding factors in his attempt to determine the effects of long-term climate change on vegetation.

Mueggler assessed the relative merits of production (dry weight estimate) and frequency[2] data along with the intensity of sampling, time of sampling, and size of sample plot. He hypothesized that species frequency might be a better method of evaluating long-term

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[2] Frequency of occurrence is a relative measure of species occurrence, and is calculated by summing the number of times a species occurs in plots, dividing by the total number of plots, and expressing the result as a fraction or percentage.

change in species abundance because it is not as appreciably influenced by the size of individual plants, which can vary considerably from year to year. His analyses led to the following conclusions:

1. If yearly monitoring of sample transects is not possible, choose a sampling method that is relatively insensitive to natural yearly variation. Mueggler suggests that frequency methods are superior to production measures in this regard, and provide a more reliable indicator of changes in species abundance.

2. Plot sampling must employ the same size of plots and should employ the same number of plots from year to year. Plots should be located at the same place within a sampling area from year to year to reduce variability introduced by random plot placement.

3. On mountain grasslands, a 0.25m^2 plot is optimum for obtaining meaningful data on most species, with smaller plot sizes resulting in significant reductions in the number of species recorded and larger plots (to 0.5m^2) resulting in insignificant differences in frequency data for commonly occurring species.

4. Plots should be visited at least twice during the growing season so that change in all plant species can be monitored (early ephemeral species and main-season species).

Vegetation communities within and outside the Wainwright Dunes Ecological Reserve are affected similarly by short-term climatic variations; productivity decreases during dry years and during years when grasshopper populations are at a peak. Muegglers' sampling considerations are therefore applicable to sampling vegetation in the Reserve, and provided the rationale for planning and initiating data collection in 1993.

2.3.2.1. Plot sampling

The main determinants of the size, number, and distribution of plots, and the type of data collected from them, are as follows:

1. Plot size and number of plots required for collecting statistically testable samples. Mueggler(1992) employed 150 - 0.25m^2 plots (total area 37.5m^2) and 48 - 0.49m^2 plots (total area 23.5m^2) in each of two grassland areas in Montana. He found that both types of plot detected frequency changes in all major species and most minor species. The smaller plots coupled with a higher sampling intensity gave a somewhat more sensitive measure of frequency change for uncommon species, but likely took longer to sample.

2. Landscape features that control how plots can be arrayed. In the Wainwright Dunes area, dune ridge landforms tend to have reasonably consistent physical characteristics over short distances of less than about 30 metres parallel to slope and less than about 20 metres perpendicular to slope. Similarly, sand flats are consistent for relatively short distances (usually less than 100m along a line parallel with adjacent dunes and less than 20m along a line perpendicular to adjacent dunes). These dimensions provide the approximate limits for plot distribution to ensure that all plots are influenced similarly by physical site factors.

3. Data to be collected. Frequency data is simple and fast to collect, assuming that the collector is adept at species identification. Biomass estimation, which Mueggler (1992) used to gauge productivity, is difficult to do consistently and requires the investigator to calibrate estimates with actual weight data on a regular basis. Percent foliar cover estimates are easier to make and provide an additional measure of species abundance, but are heavily dependent on the observers' experience. Cover class estimates such as Daubenmire classes (1=0-1%; 2=2-5%; 3=6-15% etc.) are a compromise and allow observers to reach quick and reasonably consistent cover estimates.

Plot layout

The basic sampling unit in benchmark plot sampling within the Reserve is the microplot; 10 - 0.5m^2 circular microplots are set at five metre intervals along a surveyed, permanently marked line transect. One transect is located within each of the sixteen benchmark sites discussed in Section 2.3.1 (table 2). Three transects were established and initially sampled in 1993 in each of the two main vegetation communities (grassland and aspen) on the dune ridges, for a total of 30 microplots in each community type. Ten transects were established and sampled on the sand flats type in each of the grazed and ungrazed areas for a total of 50 microplots in each area. This sampling intensity is consistent with that discussed by Mueggler (1992). Circular microplots are used because they minimize sample variance relative to square and rectangular plots for a given sample size.

Each transect on dune ridge sites is divided into two twenty-metre segments running parallel to contour, each segment having five microplots arrayed along its length. The upper segment is marked at either end by a steel pin; the lower segment is five metres downslope perpendicular to contour. The two transect segments are located such that the midpoint of the slope lies exactly between the two segments. For example, if the slope is 18 metres long (measured from crest to base of slope, the slope midpoint is at nine metres below the crest, the upper transect segment is 6.5 metres below the crest and the lower segment is 12.5 metres below

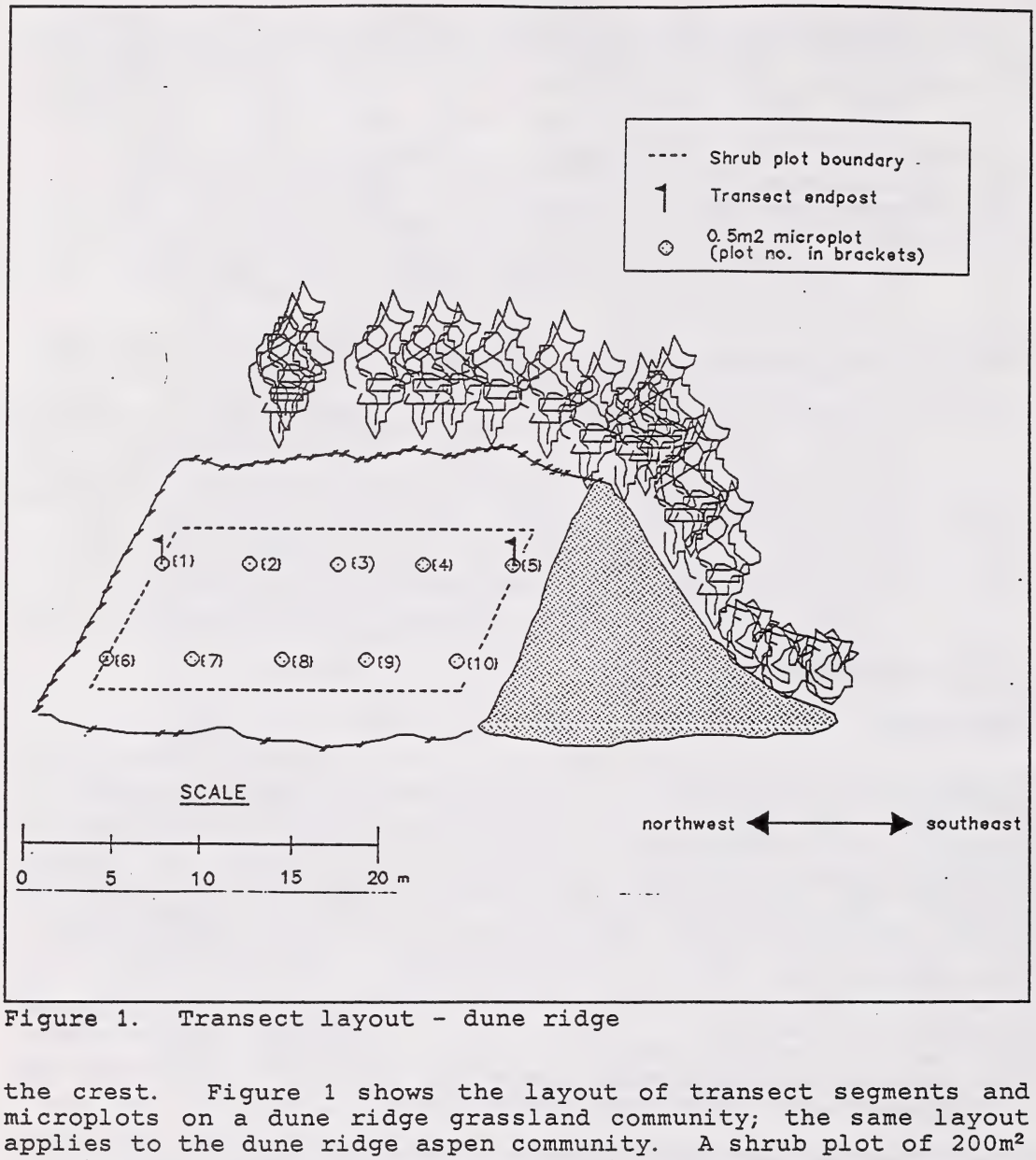

Figure 1. Transect layout - dune ridge

the crest. Figure 1 shows the layout of transect segments and microplots on a dune ridge grassland community; the same layout applies to the dune ridge aspen community. A shrub plot of 200m² area includes the twenty metre length of the transect segments, and is ten metres wide.

Transects on the sand flats sites are 50 metres in length, and are marked at the northerly and southerly ends by steel pins. The first microplot is established five metres from the northerly pin and miroplots are thereafter spaced at five metre intervals. A shrub plot of 200m² runs the length of the transect and is four metres wide. Figure 2 shows transect and shrub plot layout on a

sand flats site.

Data recording

Data is collected from each transect on Public Lands MF5 Vegetation Inventory forms. Up to fifteen microplots can be recorded on these forms, however, benchmark site surveys require that ten be

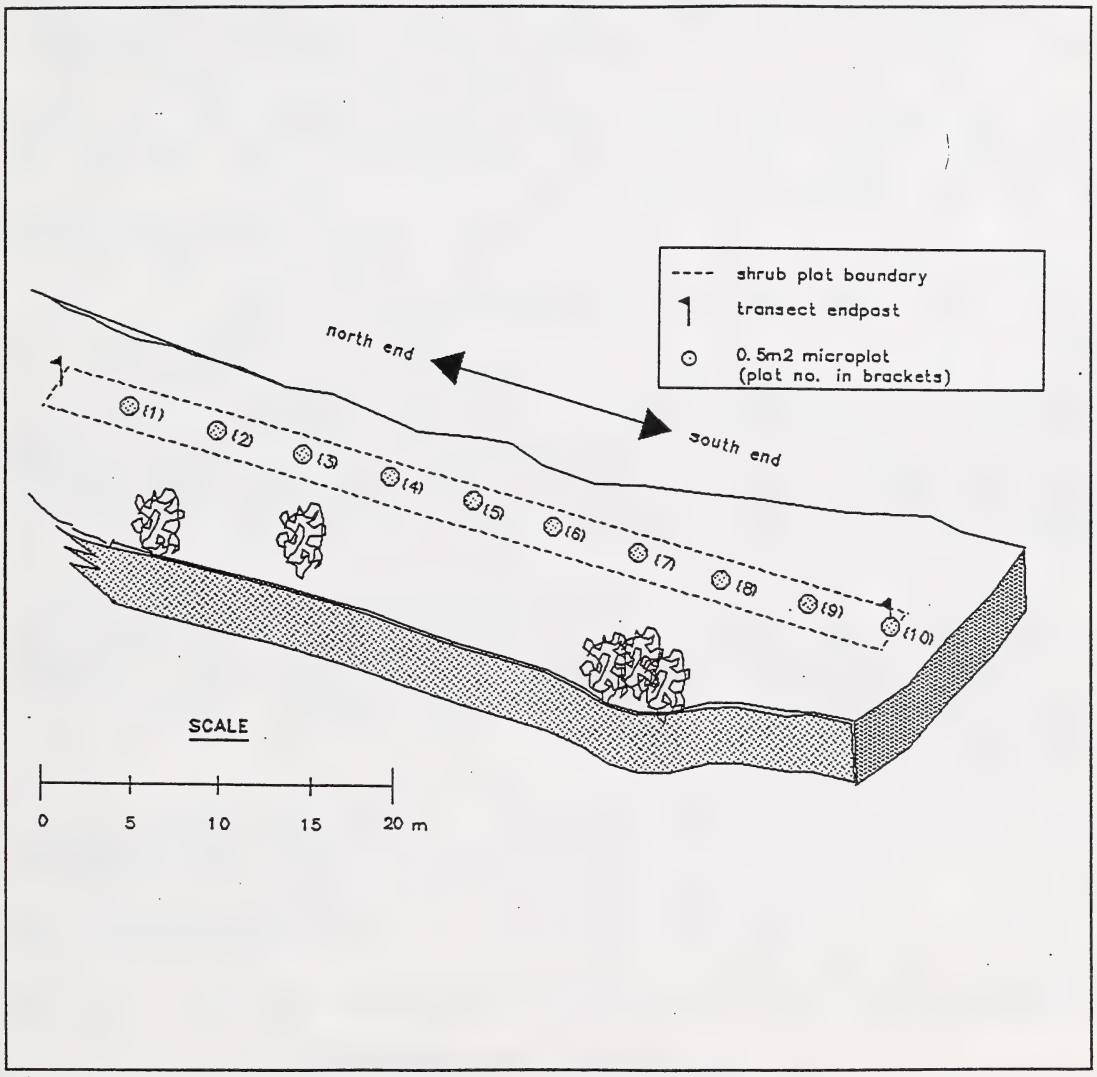

Figure 2. Transect layout - sand flats

completed. The transect number and the date of sampling are recorded at the top of each form; other information is optional.

Along the left side of the form in the species column, record the seven letter code for each species observed along the transect. Valid codes are given in the Alberta Plants and Fungi - Master Species List and Species Group Checklists (Alberta Energy/Forestry Lands and Wildlife 1992). Estimate the percent cover of each species inside the circular microplot frame at each of the ten microplots, and record the appropriate Daubenmire cover class value. In order that data be consistently collected over time, it is a good idea to sample in the same direction each time the transect is sampled, so that change within individual microplots can be tracked if desired. Microplot numbers are shown in Figures 1 and 2. It is not necessary to complete the calculations in the right-hand columns, as these calculations can be automated. If necessary, continue recording species and covers on the MF5 'Continuation Form', ensuring that the transect number and sample date are recorded at the top of the form.

Shrub cover estimates from the shrub cover plot should be recorded on the reverse side of the MF5 form. Use valid seven-letter codes as discussed above, and record density distribution class, median height and percent cover estimates. Other information on the reverse side of this form may also be completed if desired. If grazing intensity appears to have changed, it is important to note the direction and apparent magnitude of such changes and whether or not management action is needed to control grazing. This is particularly important in the ungrazed benchmark sites in the northwest part of the Reserve, as these are the control sites against which the effects of grazing on the northeast portion of the Reserve are being compared.

Photographs can be valuable in demonstrating vegetation change from year to year or in dry vs. wet years. Photographs should be taken using Kodak Ektachrome (TM) 100ASA film or equivalent; slides should be annotated with transect, plot number and date of photograph.

Timing of survey

Site visits should ideally be made twice in each growing season, the first when spring-flowering plants are in bloom (approximately mid-May) and the second when most plants have reached their maximum vegetative development (mid-June within the Reserve). However, if only one visit can be made, it is probably best to visit during the latter period.

3. DATA ANALYSIS AND REPORTING

Data analysis involves: the electronic capture of transect data; the calculation of various summary statistics for each species, for the each individual transect, and for groups of transects (e.g. ungrazed and grazed transects); and the comparison of transect groups to assess change due to grazing or other factors.

Data should be keypunched and summary statistics including average percent cover (calculated from midpoints of Daubenmire cover classes), percent composition, frequency, and prominence value should be calculated[3] for each species by individual transect and by transect group. Species frequency between groups (grazed and ungrazed sand flats transects) may be compared using either chi-square statistic or an arcsine transformation of percentage data. Groups may also be compared using species prominence value through either parametric (analysis of variance) or nonparametric techniques, depending on whether assumptions of equal variance and normality are met.

Reports summarizing the direction and magnitude of change, if any, should be prepared in a format suitable for the audience intended. Two reports might be prepared, one oriented toward technical readers and another toward other interested persons without a technical background. Comparative photographs will be useful particularly in the latter type of report.

4. SITE ESTABLISHMENT AND PROTECTION

4.1 Site establishment

Sites were established in June 1993 by staff of the Resource Information Division. In cooperation with Public Lands, two areas were designated as 'grazed' and 'ungrazed' (refer to Section 1.4) and benchmark sites were selected within these areas according to criteria discussed above (Section 2.3.1). Detailed site and soil information was collected at each site, and a transect was established according to criteria set out in Section 2.3.2.1. The endpoints of each transect are permanently marked by a square steel pin approximately one metre in length, driven approximately 70 centimetres into the sand. An aluminum tag attached to each post identifies the transect by site number (eg. "34WD0001, W end"). A staff compass set to the appropriate declination was used to record transect direction relative to true north; in the event one post is damaged or removed, the transect can be re-established from the remaining post. Transect locations were marked on 1:5000 scale color infrared photographs. Detailed vegetation information was collected for 1993 in the first and second weeks of June according to methods and criteria discussed above.

4.2 Site protection

Ungrazed benchmark sites are currently protected by natural features (wetlands) extending north-south through the approximate

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[3] Prominence value is a measure of relative importance which includes both the average cover of a species and its frequency of occurrence on a transect. It is calculated as:

Prominence value=(avg. cover)*$\sqrt{}$(%frequency/100)

centre of the north half of the Reserve and by fences along the western boundary of the Reserve. Grazed sites are currently protected by management plans controlling the duration and herd size of cattle. If substantial changes due to cattle grazing are noted on 'ungrazed' sites, it will be necessary to control such grazing, otherwise these sites will lose their value as control sites against which changes due to cattle grazing on 'grazed' sites can be compared.

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RESULTS OF 1993 SURVEY
GRAZED AND UNGRAZED SANDFLATS RANGE TYPES
WAINWRIGHT DUNES ECOLOGICAL RESERVE

1. INTRODUCTION

Vegetation and site surveys were conducted from June 8-17 1993 according to methods outlined in Terms of Reference: Wainwright Dunes Ecological Reserve Benchmark Site Monitoring. The purpose of these surveys was primarily to address the main working hypothesis given in the Terms of Reference, which is as follows:

> There is no difference in vegetation composition between sites that receive no or very low cattle grazing pressure and sites that receive a significant level of cattle grazing pressure.

The results given below therefore summarize the survey findings for ten plots sited on sandflats throughout the study area, five of which occur in 'ungrazed' areas and five of which occur in 'grazed' areas. The selection of these sites and an enumeration of each is given in sections 2.3.1 and 2.3.2 of the Terms of Reference.

2. ANALYSIS METHODS

Vegetation data collected along transects were recorded in the field on Public Lands MF5 Vegetation Inventory forms and transferred to electronic flat files. These files were analyzed using SAS(TM) software in the following manner:

1. A full species-plot matrix containing all species with their associated cover estimates occurring in all plots was created.

2. The total number of times each species occurred with greater than 0% cover was calculated for each transect (10 microplots) and for transect groups belonging to each site type ('Grazed' or 'Ungrazed'; 50 microplots in each type).

3. Average cover of each species was calculated for each transect (10 microplots) and for each transect group in each of the two site types (50 microplots). Average cover is calculated from midpoints of the Daubenmire cover classes used to record species cover as follows:

DAUBENMIRE CLASS	RANGE(%)	MIDPOINT(%)
1	0-1	0.5
2	1-5	2.5
3	5-25	15.0
4	25-50	37.5
5	50-75	62.5
6	75-95	85.0
7	95-100	97.5

4. A prominence value was calculated for each species for each site type (pooled microplot data from 50 microplots); this provides a relative measure of species importance which incorporates both its average cover and its frequency of occurrence in the relation:

$$\text{prominence value} = \text{average cover} * \sqrt{(\text{frequency } \%/100)}.$$

5. A listing of dominant species was prepared (those with a prominence value of >0.5) for each of the 'grazed' and 'ungrazed' transect classes.

6. Species frequencies between transect groups belonging to 'ungrazed' and 'grazed' site types were compared using two different methods, the chi-square comparison and the arcsine transformation of frequency data (Sokal and Rohlf, 1968). Frequency is considered a better method than cover of detecting species change, as discussed in Section 2.3.2 of the Terms of Reference.

7. A nonparametric test of differences between transect groups belonging to 'grazed' and 'ungrazed' site types was performed, using prominence value as the analysis variable.

3. RESULTS

3.1 Vegetation descriptions

Tables 1 and 2 summarize dominant species occurring in each of the 'grazed' and 'ungrazed' transect groups, organized by descending order of prominence value. Both transect groups

TABLE 1. DOMINANT SPECIES IN WAINWRIGHT ECOLOGICAL RESERVE: "GRAZED" SITE TYPE

LATIN NAME	PROMINENCE VALUE	PERCENT FREQUENCY
ALL MOSSES AND LICHENS	40.6451	98
Cladina mitis	38.6849	98
Juniperus horizontalis	27.4179	64
LITTER	15.2000	100
Selaginella densa	8.0870	78
Festuca scabrella	7.5698	74
Carex obtusata	5.9825	98
Cladonia pocillum	2.3651	62
Koeleria macrantha	2.1806	68
Solidago missouriensis	1.4550	62
Calamovilfa longifolia	1.2332	58
Carex siccata	1.1892	62
Festuca saximontana	0.8692	62
Carex pensylvanica	0.5633	58

PROMINENCE VALUE= AVERAGE COVER * SQUARE ROOT(%FREQUENCY/100)

TABLE 2. DOMINANT SPECIES IN WAINWRIGHT ECOLOGICAL RESERVE: "UNGRAZED" SITE TYPE

LATIN NAME	PROMINENCE VALUE	PERCENT FREQUENCY
ALL MOSSES AND LICHENS	49.9800	100
Cladina mitis	42.3031	90
LITTER	27.4000	100
Juniperus horizontalis	18.5697	64
Carex obtusata	7.6697	98
Calamovilfa longifolia	3.8335	80
Festuca scabrella	3.4774	30
Selaginella densa	2.8594	68
Carex siccata	2.7941	66
Festuca saximontana	1.4225	48
Cladonia pocillum	1.1820	48
Arctostaphylos uva-ursi	0.8321	8
Geum triflorum	0.8199	14
Antennaria parvifolia	0.8115	12
Populus tremuloides	0.5644	6
Parmelia chlorochroa	0.5609	14
Cetraria ericetorum	0.5501	36

PROMINENCE VALUE= AVERAGE COVER * SQUARE ROOT(%FREQUENCY/100)

occurred on similar sites, which are characterized by physical features outlined in Table 1 of the Terms of Reference under the "Sand flats" category.

These tables show that the overall species composition is similar between 'grazed' and 'ungrazed' site types. There are a few apparent differences in relative abundance and presence as indicated by prominence values and percent frequency values, respectively.

3.2 Statistical analyses

A nonparametric analysis of species prominence values between 'grazed' and 'ungrazed' areas was performed and is summarized in Table 3. Differences were detected in five of 69 species (the full species list includes 'Litter', 'All mosses and lichens' and 'Exposed soil').

Tables 4 and 5 summarize the statistically significant differences in species frequency of occurrence between 'grazed' and 'ungrazed' site types ($\alpha = 0.05$); two different methods of analyzing frequency data are represented in the tables. It appears that the arcsin transformation of species frequency data is a more sensitive indicator of differences than the chi-square method, with 26 differences detected by the former and 15 differences by the latter. About half of these differences between 'grazed' and 'ungrazed' site types involve species that occur with low frequency (less than 20 percent of microplots along all transects belonging to each site type), however. These species might be present in one site type and absent or present with lower frequency in the other site type due to factors other than grazing, such as environmental differences undetectable at the scale of investigation, other types of disturbance, or the ability of plants propagules to establish populations.

Table 3. Wilcoxon rank-sum test of differences in species prominence value between 'grazed' and 'ungrazed' areas ($\alpha=0.05$).

SPECIES	'GRAZED' AREA PROMINENCE VALUE	'UNGRAZED' AREA PROMINENCE VALUE
Artemisia frigida *	0.4	0.02
Calamovilfa longifolia*	1.2	3.8
Cetraria nivalis *	0.01	0.2
Litter	15.2	27.4
Solidago missouriensis*	0.1	1.5

* species marked with an asterisk also differ in frequency (refer to tables 4,5)

4. DISCUSSION

Of those species occurring with significantly different frequency and/or prominence values, there are several notable differences:

- Rough fescue (Festuca scabrella), junegrass (Koeleria macrantha), low goldenrod (Solidago missouriensis), pasture sage (Artemisia frigida) and lichen (Cetraria islandica) occur with significantly higher frequency on 'grazed' than on 'ungrazed' transect groups.

- Sand grass (Calamovilfa longifolia) and lichen (Cetraria nivalis) occur with significantly lower frequency on 'grazed' than on 'ungrazed' transect groups.

- Litter cover was present on all microplots in each of the 'grazed' and 'ungrazed' transect groups. However, there is a statistically significant difference in prominence value between the two groups ('ungrazed' prominence value=27.4, 'grazed' prominence value=15.2). These differences were calculated on the basis of class midpoint values; there appears to be a difference of about one Daubenmire class between the 'grazed' and 'ungrazed' transect groups.

TABLE 4. COMPARISON OF SPECIES FREQUENCY (PERCENT) IN "GRAZED" AND "UNGRAZED" SAND FLATS: WAINWRIGHT DUNES ECOLOGICAL RESERVE *

Species Code	Grazed %freq	Ungrazed %freq	Significant Difference
Agropyron pectiniforme	8	0	**
Anemone patens	10	0	**
Antennaria parvifolia	12	12	
Artemisia frigida	36	6	**
Artemisia ludoviciana	12	12	
Calamovilfa longifolia	58	80	
Campanula rotundifolia	28	8	**
Carex obtusata	98	98	
Carex pensytvanica	58	42	
Carex siccata	62	66	
Cerastium arvense	52	50	
Cetraria ericetorum	30	36	
Cetraria islandica	42	16	**
Cetraria nivalis	4	34	**
Cladina mitis	98	90	
Cladonia pocillum	62	48	
Elymus canadensis	2	6	
Equisetum hyemale	10	24	**
Festuca saximontana	62	48	
Festuca scabrella	74	30	**
Geum triflorum	4	14	**
Helictotrichon hookeri	28	20	
Juncus balticus	0	6	**
Juniperus horizontalis	64	64	
Koeleria macrantha	68	46	**
LITTER	100	100	
ALL MOSSES AND LICHENS	98	100	
Parmelia chlorochroa	10	14	
Rosa arkansana	16	26	
Selaginella densa	78	68	
Senecio canus	8	0	**
SOIL (EXPOSED)	16	14	
Solidago missouriensis	62	22	**
Stipa comata	16	12	
Thermopsis rhombifolia	6	0	**
Tortula ruralis	18	4	**

** = significantly different @ $\alpha = 0.5$

* Method of comparison: **chisquare** (Sokal and Rohlf 1968). A total of 100 microplots (50 in each of the "grazed" and "ungrazed" site types) were sampled. A frequency value of 12%, for example, indicates that the species occurred in 6 of 50 microplots.

Only species occurring in either of the two site types with > 10 percent frequency or occurring with significantly different frequencies are included.

TABLE 5. COMPARISON OF SPECIES FREQUENCIES (PERCENT) IN "GRAZED" AND "UNGRAZED" SAND FLATS: WAINWRIGHT DUNES ECOLOGICAL RESERVE *

Species Code	Grazed %freq	Ungrazed %freq	Significant Difference
Agropyron pectiniforme	8	0	**
Anemone patens	10	0	**
Antennaria parvifolia	12	12	
Artemisia biennis	0	4	**
Artemisia campestris	4	0	**
Artemisia frigida	36	6	**
Artemisia ludoviciana	12	12	
Calamovilfa longifolia	58	80	**
Campanula rotundifolia	28	8	**
Carex obtusata	98	98	
Carex pensylvanica	58	42	
Carex siccata	62	66	
Cerastium arvense	52	50	
Cetraria ericetorum	30	36	
Cetraria islandica	42	16	**
Cetraria nivalis	4	34	**
Cladonia ericitorum	0	4	**
Cladina mitis	98	90	**
Cladonia pocillum	62	48	
Cladonia/Cladina spp.	0	4	**
Equisetum hyemale	10	24	**
Festuca saximontana	62	48	
Festuca scabrella	74	30	**
Geum triflorum	4	14	**
Helictotrichon hookeri	28	20	
Juncus balticus	0	6	**
Juniperus horizontalis	64	64	
Koeleria macrantha	68	46	**
LITTER	100	100	
ALL MOSSES AND LICHENS	98	100	
Parmelia chlorochroa	10	14	
Polytrichum piliferum	0	4	**
Rosa arkansana	16	26	
Rosa woodsii	4	0	**
Selaginella densa	78	68	
Senecio canus	8	0	**
Silene drummondii	0	4	**
Smilacina stellata	4	0	**
SOIL (EXPOSED)	16	14	
Solidago missouriensis	62	22	**
Spiraea alba	4	0	**
Stipa comata	16	12	
Thermopsis rhombifolia	6	0	**
Tortula ruralis	18	4	**

** = significantly different @ $\alpha = 0.5$

* Method of comparison: arcsin transformation (Sokal and Rohlf 1968). A total of 100 microplots (50 in each of the "grazed" and "ungrazed" site types) were sampled. A frequency value of 12%, for example, indicates that the species occurred in 6 of 50 microplots.

Only species with greater than 10% frequency in either of the two site types or demonstrating significant differences are included in this table.